ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGRAW-HILL PUBLISHING COMPANY, INC.
JAMES H. McGRAW, *Chairman of the Board*
MALCOLM MUIR, *President*
EDWARD J. MEHREN, *Vice-President*
H. C. PARMELEE, *Editorial Director*

F. E. SCHMITT, *Editor*

WILLARD CHEVALIER
Publishing Director

Volume 102 | NEW YORK, JANUARY 3, 1929 | Number 1

THIS issue is given over to highway construction, in recognition of the remarkable recent developments in that field. The country has been spending $1,500,000,000 a year on its roads, but traffic is rapidly outgrowing the highway. New conceptions and new planning are therefore coming to the fore; an epoch of highway development is closing and another is beginning. The main facts of this transition are outlined by leaders of current thought.

A New Era of Highway Development

NEW problems confront highway engineers. The decade since road construction was resumed following the war has been one of intensive improvement. Enormous sums have been spent, and now each year's roadbuilding cost is nearly a billion and a half dollars. States and counties are straining their resources to carry on the program. Withal, only a fraction of the highways has been brought to engineering standards. The use of the motor vehicle is every year increasing faster than is the mileage of improved roads. Vehicle owners are demanding more roads and wider and safer roads and roads which give a service to travel that was outside the boundaries of thought ten years ago. The situation sketched in these words calls for new highway thinking of a comprehensive kind.

It must embrace a wide range of accomplishment and requirement. In particular it must avoid being diverted into narrow ways by local predominance of special conditions and requirements. That certain road routes and groups of roads, for example, require perfecting in every manner that intensive and exacting traffic can demand is not a reason for considering that the extension of surfaced mileage of all roads is not a pressing duty. But the new thinking does require that thought of mileage extension shall be predicated on ultimate road service. Our thinking is now of immediate road service. We may not make all roads four-track roads, but we can in carrying out improvement conceive of every road as an ultimate four-track road. Two-track thinking must be changed to four-track thinking in all phases of public-roads improvement—financing and administration as well as engineering design and construction.

THIS kind of thinking will look upon the road as primarily a tool of transportation. It has been too much considered merely an engineering structure—a strong, durable and reasonably smooth way for travel between places where travel desired to go. Now, as a tool of transportation it has to be considered also a means for encouraging, safeguarding and pleasuring travel. The new conception includes all that is essential of the old, and adds the idea of use, of service. Obviously the new thought of the highway as a functioning agency of transportation forecasts new problems for the highway engineer. What are these problems and how are public-roads administrations fitted, on the record of past performance, to meet them? This issue presents in part the answer.

Outstanding is the demonstration that traffic controls the highway. As the chief of the Bureau of Public Roads calls on history to show, the road has ever been the servant of the vehicle. It is in extending the radius of the motor truck, as shown by Professor Chatburn, that the road multiplies the market and social opportunities of the farmer and increases farm-land values. It is to serve traffic that the safeguards and signs, the camping grounds and comfort stations and the parks and plantings described by Commissioner Hines have become parts of improved roads. It is the volume, kind and frequency of traffic as shown by Doctor McKay that determines road design; without knowledge of these factors planned and designed road systems are impossible. Emphasis on the controlling influence of the vehicle and its use is the fundamental theme of the issue.

IS TRAFFIC being served adequately by the present improved highway? In general it is not. There are congestion and delay, there are lack of safeguards and the presence of unnecessary hazards, there is want of comfort and convenience, there is lack of mileage of improved roads. No censure is implied in these truths. Public-roads officials have done as well perhaps as they could, during a time of flux in every policy and practice of roadbuilding. They perforce have had to think of immediate ways and means. But at the present juncture, to serve traffic adequately there has to be new thinking from the changed viewpoint of traffic service, and this thinking has to call on the past for its lessons, on research for its determination of fundamentals, and on something of prophetic insight for its forecast of the future.

The financing of future highways, their design and their construction have to meet new demands. The problem of financing as stated and analyzed by Professor Agg is discussed in a succeeding column. Construction, probably the most advanced of technical achievements in roadbuilding, is also separately remarked on. Design, the least perfected of either present or future roadbuilding tasks, calls for more particular consideration.

EXCEPT in paving-slab structure, highway design of today falls short of requirements and presents few constructive prospects for the future. Almost everywhere

constrictions of traffic exist. Narrow bridges and underpasses, sharp curves, blind intersections and crossings, and traffic-congested links through city streets prevail generally. With respect to free flow of traffic the modern highway structure is a succession of broad reaches and bottlenecks. The situation is hardly better in respect to signs and markings, and signaling is a travesty on logic and sanity. Indeed, full citation of engineering design faults of the modern improved road as a tool of transportation would pass all reasonable space limits. Neither as a structure nor as a free way for travel does it satisfy the requirements of good engineering location, planning and operation. Again censure falls on the faulty conception of the highway rather than on the builder individually. The highway has not been comprehended as a device solely to serve traffic. This is to be the accomplishment of the future.

IT IS with the purpose of bringing into plain view the function and purpose of the public road and to prompt new thinking in highway design, construction and operation that the articles in this issue were invited by us and were prepared by men who lead in highway engineering knowledge and accomplishment. They can be but the beginning of a constructive work in changing roadbuilding ideas and ideals which will be carried on as the year advances by leading thinkers and practitioners in public-roads engineering and administration. The need of this work is imminent not because highway engineering has done so poorly in the roadbuilding of the last ten years but more because it has done so remarkably well.

There is a new era before the engineering profession in highway development—the era of traffic service. Its tasks are great; they involve enormous expenditures of money, and the wisest counsel is needed in their accomplishment. The powers of research, designing skill and construction ability are all required. Knowledge of finance and training in administration are necessary. And finally there has to be acumen and wise judgment in safeguarding, conveniencing and pleasuring vehicle movement. The problem is worthy of all that engineering talent can bring to its solution.

Future Road Financing

LOOKING into the immediate future of road construction, the need for more money with which to build and maintain our highways is clearly apparent. Not only will the present rate of expenditure continue but more ample funds must be provided. Professor Agg's estimate of twice the present annual expenditure does not seem out of reason. How is this flow of money to be provided?

One essential fact which bears on this future financing is that roads today are a plain matter of business, and no longer are an object of general enthusiasm. Financing plans that ignore this change will be in danger of shipwreck. Fifteen and twenty years ago roadbuilding was a big popular movement. A paved-road system had to be created, for there were no roads that could carry fast or heavy vehicles. Road funds were voted easily. No one objected to taking these funds from general tax moneys; no one asked whether the allocation of the burden was precisely equitable. It was felt that everybody would benefit and, in any event, that the demand for money would soon end or at least decrease. Today's attitude toward roads is fundamentally different. The road is looked upon in a hardheaded business way as a tool, an income-producing investment.

This attitude will control future financing. Our current resources are ample for all the road investment that may be needed or desired; but if roads are needed, so are many other things—public buildings, better water supplies, refuse-disposal plants, and whatnot. Thus the road will meet sharp competition in its claim for the money of those who pay taxes and fees. The money can be obtained if it is taken out of the profits which the road investment produces; it is unlikely to be obtained on other terms.

In considering a financial program such as road construction will require, one is tempted to look toward all possible sources of revenue. But it may be set down as certain that road moneys cannot and will not be raised by any such simple process as taxing whatever appears taxable. The road money of the future is likely to come only in fair and just proportion to the benefits which roads confer. In other words, pay-as-you-go financing is the fundamental principle of the coming road program. This principle has two main corollaries: first, that the source of money should be the profits which the road earns, and second, that not all of the profits should be taken as a tax, nor any element of profit be taxed twice.

Road use is undoubtedly the fairest and best available measure of returns so far as the road user is concerned. The proper charge for this has been divided by Professor Agg into a gasoline tax—which may be considered a combined mileage and tonnage charge—and a vehicle fee, the equivalent of a readiness-to-serve charge. That such charges are sound and equitable is hardly open to question. In their detail application, important questions will doubtless arise, particularly concerning the vehicle tax, which today has many arbitrary features—for example, the abnormal imposts placed on buses and the fanciful discrimination between different private automobiles. However, with due attention to these details, it seems beyond question that vehicle fees as a minor source and the gasoline tax as a major source will produce the largest part of future road funds.

One other good-roads benefit requires study: the increased value of land along improved roads. In all justice this should be utilized as a source of contribution to road construction. It is a very important factor in the profit returned by roads. Yet up to the present it has been only infrequently drawn upon as a source of construction money. The difficulty involved in placing it under contribution, which may be perceived through Professor Chatburn's study of the subject, is probably the main reason for this. There are few definite facts on land-value increases due to road improvement, and no established methods of levying on this unearned increment for the purpose of repaying road cost. It would seem that there are possibilities in taxing the land profits, but little likelihood of the practical raising of any large revenues from this source in the early future.

On present outlook, then, gasoline taxes and vehicle fees must be the source of revenues for financing future road construction and maintenance. Their proper application requires that they be used not only for new work but also for the amortization of past road-bond issues. If they are so applied, and if further bond issues are suitably based on the principle of repayment from road use, the important work of developing our road system will be sound and can be carried on as rapidly as good business warrants.

Editor's Notes

Co-ordinated Research

JUST as research underlies most progress, so it is basic to future highway development. There is much to be done, however, in the direction of its co-ordination. Laboratories of highway departments, of colleges and of industrial associations, with the various federal research bureaus, provide ample equipment and expert direction. They are capable of important work and have done much that deserves this definition, but they are working independently, often at odds and to no co-ordinated program. In particular they have in large measure no adequate means of disseminating their findings; there is a wealth of research results which is virtually limited to a few for lack of publication. In all, the present organization of highway research presents an almost impossible situation in the working out of any program of scientific development of highway transportation. A co-ordinating and program-creating force is needed which can sweep aside the barriers to free co-operation of existing public and private laboratories and their exchange of the products of scientific investigation. Exchange now exists, but it is limited by many inhibitions. Co-operation joined with planning can work great things, without sacrifice of independence. The time seems especially right for the task. Research is an accepted doctrine. Virtually every element of the industry is technically minded. Associations of materials producers and equipment manufacturers have technical directors. There are testing and research divisions in all state highway departments. Stimulation to concerted action is all that these agencies require. It will come as soon as a co-ordinated program is presented by a directing body with force and purpose enough to command their participation.

Machines and Management

WITH the remarkable development of machine methods of roadbuilding that are described in this issue there has come an intricate problem of plant management. Machines for roadbuilding have multiplied so rapidly and have changed form so often in the last half-dozen years that constructors have been preoccupied in keeping their mechanical outfits physically abreast of improvements. This has delayed the economic study of assemblages of machines into construction plants. The rapid entrance of machinery has also found the constructor unprepared to think and work in the terms of machinery, and particularly of virtually complete mechanization, instead of in terms of manual labor with partial machine assistance. He has not immediately sensed the difference and magnitude of the changed construction problem. These conditions are true of all construction; in roadbuilding they are emphasized. The problems of plant engineering and management are much of the kind that confront the manufacturer, but are complicated by the fact that the plant is continually changing location. It is therefore a special problem that confronts the roadbuilder and it calls for new thinking. There is evidence that he yet has opportunity for grasping the fullness of this task. Progress in output such as is recorded by C. M. Hathaway elsewhere is the result rather of the great capacity of machines than of developing the potentiality of plant by co-ordination and close time-saving direction of operating procedure. As recent analyses of individual operations have shown, there is further progress to be made in reducing the percentage of unproductive time. The constructor's essential task is so to perfect the use of equipment that it gives all the service of which it is capable. The future calls for equipment consciousness and plant engineering of a far more intensive sort.

Burning Scaffolding

ONCE again the fire hazard of large and dense masses of wood scaffolding has been demonstrated, exacting a toll of several hundred thousand dollars from a structure of major proportions. This time, as was not the case in the Sherry-Netherland fire in 1927, the builder appreciated the danger and had apparently taken all precautions that long experience suggested; and yet all these proved not enough. Wherein they were lacking is one of the important lessons to be learned from the destructive fire in the partly completed Riverside Church in New York City last week. The contractor had drawn unstintingly from the whole list of modern concepts of fire-prevention measures in order to avoid the very disaster that overtook him. A standing order to remove all accumulations of rubbish after each day's work had been in operation and presumably had been complied with on the day of the fire. Chemical fire extinguishers in seemingly adequate number were distributed in the building. Two standpipes had been carried up with the work so that water at high pressure would be available, although the rapid spread of the fire prevented their use. The building was heated from a steam plant in the basement to eliminate danger from open salamanders. Rivet forges had not been in use on the day of the fire, but they, too, had been the subject of close daily scrutiny. A watchman covered the building every two hours, being checked in his inspections by that most modern of devices on a construction job, a time-clock system. Yet all these precautions failed. It is hoped for the good of the entire construction industry that the contractor will study and analyze the failure most fully. It is not a crime to have a fire, but a real asset is lost unless every effort is made to learn what caused the fire—to determine in what details and to what degree the prevention system failed—in the hope that our knowledge of fire protection during the construction period may be increased.

Volume 102—*Engineering News-Record*—Number 1

Engineering News-Record is a consolidation of Engineering News and Engineering Record, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as The Engineer and Surveyor, which title subsequently became The Engineer, Architect and Surveyor, then Engineering News and American Railway Journal and finally Engineering News, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as The Plumber and Sanitary Engineer. The name was subsequently changed to The Sanitary Engineer, Engineering and Building Record, and, finally, to Engineering Record. During his ownership of the paper Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded in 1913 by E. J. Mehren.

The Contractor was consolidated with Engineering News-Record in 1918.

E. J. Mehren became editor of Engineering News-Record at the time of the consolidation in 1917, and was succeeded by the late Frank C. Wight in 1924. In July, 1928, F. E. Schmitt was appointed editor.

The staff of Engineering News-Record consists of—

New York: F. E. Schmitt, editor; V. T. Boughton, managing editor; M. N. Baker, C. S. Hill, W. G. Bowman, H. W. Richardson, R. B. Garrabrant and C. N. Hulburt.

Chicago: E. E. R. Tratman, W. W. De Berard.

San Francisco: N. A. Bowers.

Our Present Road System

How It Was Created and How It Grew

The Five Eras of Growth and Traffic Influences Which Have Brought the Highways of America From the "Cleared Trail" of 1664 to the Present System of 3,000,000 Miles Located and 500,000 Miles Surfaced

By Thomas H. MacDonald

Chief, U. S. Bureau of Public Roads, Washington, D. C.

Introducing the series and the theme of the series of articles of this issue, the chief of the Bureau of Public Roads in this article covers much of historical record in marvelously few words. To estimate the highway problem of the future there must be had knowledge of the origin and growth of the highways of the present. This the article by Mr. MacDonald gives us in an interpretative way. Followed by the pages of statistics and the account of progress in the design and construction of the leading types of road surfacing, this article prepares the way for the articles considering more specifically the situation of traffic, finance, construction and equipment progress and the servicing of travel by the highway.

IN THE series of articles of which this is one the editors of *Engineering News-Record* have chosen to bring before their large audience a single idea. My conception of the thought behind this series is the constructive service that may be rendered by striking a balance of past developments and accomplishments in the field of highway improvement to assist in insuring future progress toward the most valuable ends—a sort of "Stop! Look! Listen!" motive, interwoven with the recognition of large and praiseworthy past results and with the acknowledgment of definite advancement in the science of highway engineering. There is no question that we have reached the "Stop! Look! Listen!" stage. How and where we go from here will put an even higher test upon the quality and intelligence of highway leadership than the problems of the past—not in every way, but in those phases requiring the weighing and determining of the highway services required, the application of the scientific principles that are evolving, the furthering of real research and the formulating and balancing of future programs and budgets.

A New Transportation Service

In less than two decades a wholly new transportation service has been put into operation. The scale is so large in every aspect that profound disturbances have followed. Some of the facts of this period are shown in the accompanying graphs. The matters of gain and loss are not here under analysis. Rather we are concerned with the way we have come, the influences which have given direction and the evidence existing in the present status which must largely determine the more important future developments. The impacts because of the momentum now attained by highway transport are confusing, and while there is greater need for the quality of imagination in highway leadership, it must be tempered by a full appreciation of the underlying principles of engineering and finance, themselves as yet scarcely defined in terms of today's dimensions.

There is the matter of multiplied administrative bodies. Seven times seven fails to include all within a relatively small area, and yet our present needs call for co-ordination among them all, beyond any heretofore-held conception. The certainty of lessening the number can be assured only through co-ordination.

Financing is reaching a stage which no longer permits subterfuge. In the flush of delight with each year's gift of new highways, we have closed our eyes to bad practices which are nearing their own self-extinction—for example, the exhaustion of county credit to build state roads. Continuously with the development of the motor vehicle has come the pressure for the improvement of more and more mileage. This demand, yet vigorously claiming right of way, now comes into abrupt conflict with the strong, stubborn necessity for perfecting existing highways to carry traffic more adequately and more economically. In medical science much time and effort are devoted to isolating the germ. Once accomplished, the disease cure may yet be highly difficult, but the efforts are given direction and definite objectives. In this field of highway science a parallel exists which may with equal certainty be relied upon to give not only true direction to their study but proper weight to the various detailed problems composing the whole.

The Vehicle Dictates the Highway

The highway has ever taken its form and attributes from the vehicle or the character of transportation carried. Only in the details, or for relatively short periods, has the highway determined the character of design of the vehicle; never has it determined the motive power. Follow their whole development and the conclusion is inevitable that highways are the offspring of the mode of transport and take their characteristics from such a parentage.

If out of all the experience of the past we find an unchanging quality, a characteristic that has remained constant, it becomes an invaluable guide to the future, a fixed standard of measurement by which to gage accurately future policies. So in addition to recording briefly the various phases and periods of our highway history, the attempt has been made to bring out the constant factor—to isolate the germ.

The vehicle dictates the indispensable qualities of the road. Therefore the necessary highway facilities will be determined by measuring the economic utility and utiliza-

tion of the vehicle—that is, the desirable transport service with maximum economy. It seems probable that this principle has governed the whole of our highway development and will continue to do so. It is supported by the history of more than three centuries.

The Colonial and Turnpike Periods

The colonies of Virginia, Massachusetts and New York by 1664 had enacted laws providing for clearing a lane for travel of trees, undergrowth and insurmountable obstructions. The Maryland law of 1704 provided, in addition to clearing, for marking the roads by notches cut into trees along the sides and by letters set on with marking irons. In the later days of the colonies the primitive cleared roads had been sufficiently improved by the counties with labor tax for people of wealth to travel by coach-and-four between the larger population centers or to transport goods by wagon. The work done in general seems to be only that sufficient to permit the passage of stout-wheeled vehicles drawn by ample animal power. The roads were no better than the vehicles had to have, but even so, they were probably a greater cost burden than those of today because of their small earning capacity.

We may regard the colonial period as extending from 1607 to 1776. It was followed by the toll turnpike period, about 1785 to 1850.

Immediately following the Revolution the newly acquired dignity of sovereign states found one expression in an increased activity in behalf of a more adequate land transportation.

The legislature of Virginia in 1785 provided for the establishment of toll gates on the Little River turnpike west from Alexandria to the Shenandoah Valley. Connecticut followed by placing tolls on the Mohegan road and the Old Post road in 1792. A number of other states established toll roads as state projects, but in 1792 Pennsylvania granted a charter to the Philadelphia & Lancaster Turnpike Company to build a toll road, the Lancaster turnpike, 62 miles in length, from Philadelphia. This plan spread like wildfire in all the states, until thousands of miles were being built and operated by private companies. In 1808 the Secretary of the Treasury reported 770 miles completed in Connecticut and 3,000 miles completed or under construction in New York.

Few companies paid more than 2 or 3 per cent profit. Most of them failed or owned unprofitable investments by the time or even before the railroads came.

In addition to granting charters for the building of toll roads, the states, although not in equal degree, undertook the laying out and building of many miles of so-called state roads. The principle of state aid was also established by appropriations to the localities to assist them in improving roads. This state activity was prompted largely by commercial rivalry—the desire of the cities established on navigable waters, by this time grown to some importance, to hold or to extend their tributary trade area. It soon became evident as these roads were extended to considerable distances from the trade centers that the bulky goods of low value could not be transported profitably with the method at hand.

While it has often been stated that the canals and railroads put the highways out of business, it is evident that the highway transport developed inland commerce to the extent that it put itself out of business. That is, the mode of transport was no longer adequate to meet the demands of the rapidly growing commerce. A wave of canal development swept over the states, to be followed very soon by the building of railroads.

The Dark Age of Highways

One of the greatest epochs of the United States came early in the period following 1850, with the great home-seeking and gold-hunting treks to the West and Northwest. The movements of the pioneers recorded themselves in the Santa Fe, the Mormon, the Oregon and the Overland trails, but these are all records of location. They were not roads in the sense of constructed or improved highways. They were not accomplishments in highway engineering in the narrow sense, but they were supreme accomplishments in the human effort of empire building.

THE EVOLUTION OF A HIGHWAY, 1919-1928
(1) Earth road, 1919. (2) Gravel road, 1920. (3) Concrete road, 1928.

In the latter part of the period (1885) the safety bicycle was introduced, and within the next decade it swept the country before it. The advantage of the bicycle for recreation induced the enthusiast to travel afar, and it was not long before the chief aim of its users became the promotion of better roads.

In the bicycle, it will be noted, was a new vehicle for transport which if it were to be utilized to the best advantage required very good roads indeed; and in five or six years the bicycle accomplished more results in securing a definite attack upon the problem of road improvement than had been accomplished in the preceding third of a century.

State Aid and Early Federal Legislation

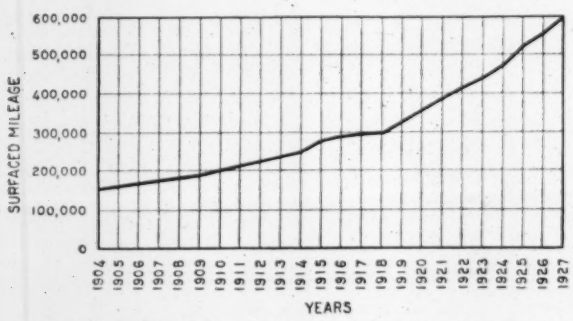
Foreshadowing the very important structure of today's highway administration, the State of New Jersey in 1891 provided for aiding the counties through funds appropriated by the state and established a state authority for administering, in co-operation with the local authorities, the use of these funds. The same principles were put into effect in Massachusetts in 1892, in Connecticut and California in 1895, in Maryland, New York and Vermont in 1898. The two elements of the New Jersey law, state-aid funds and state engineering supervision, were curtailed by many of the states to the single one of

extending engineering advice, conducting demonstrations and gathering information, all of which might be accepted or rejected by the local authorities at their discretion.

The federal government followed the same principle in establishing the office of road inquiry in the Department of Agriculture by an act approved March 3, 1893. The authority granted was for the collection and dissemination of information, and the first appropriation was $10,000.

While in many of the states the organization and funds provided were extremely limited, nevertheless these laws were very important, the majority of them marking the first adventure in the field which has now become the most important state activity, measured by the annual expenditure.

This same period was marked by the formation and activity of a large number of organizations devoted to



SURFACED MILEAGE OF RURAL ROADS BY YEARS

furthering ways and means to accomplish highway improvement. In addition to the educational activities carried on to enlarge the information of their own members and of the general public, all of these organizations have been very active in helping to frame and to secure legislative support from the state legislatures and from the United States Congress.

The Beginnings of the Modern Technical Art

The importance of the small beginning made by a number of states in establishing an organization without funds to build roads and with only limited appropriations to gather and to disseminate information was not at the moment appreciated. It has not been until recent years that the real significance of this small beginning has been manifest. These organizations attracted young, enthusiastic technical graduates whose first duty was to acquire information. In these states also—Illinois is a good example—the idea of research was given strong support to make the best possible use of available resources and to develop methods best adapted to the particular conditions met within the state.

Beginning in 1907 a number of the state highway departments of the Mississippi Valley met in annual conference, and there soon began to grow out of these contacts plans and specifications for roads, for materials and for bridges particularly adapted to that area. Later similar associations were formed by the Eastern highway departments and by the Western highway departments.

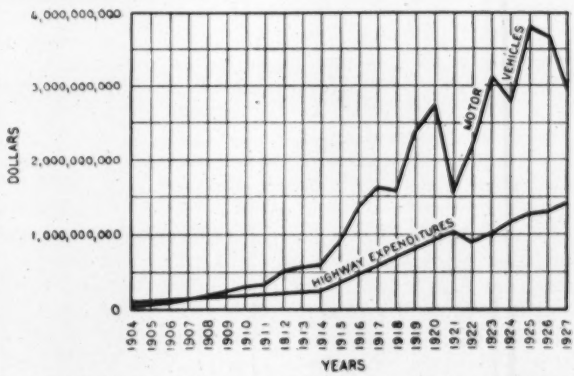
In 1914, at the call of Logan Waller Page, director of the Bureau of Public Roads, representatives of a number of the state highway departments met at St. Louis and planned a national organization of state and federal highway officials. This organization was perfected at a meeting in Washington in December, 1914, and thus was formed the American Association of State Highway officials. This organization undertook at once the preparation of legislation to submit to the federal Congress for the purpose of securing federal appropriations to assist the states in the development of their road programs. A bill was drafted, approved by the association, submitted to Congress, and made a law on July 11, 1916. Thus was initiated the modern period.

At the close of the period just considered, 1890-1916, 42 states had made appropriations and were contributing state aid to the counties or towns. A few of these were also working on state road programs independently of the counties. In the other states the road funds were being used by the local authorities under the supervision or with the help of the state highway organization. Six states had as yet no state highway organization of whatever character.

In 1902 Rhode Island provided for laying out and building at state expense a system of state roads. A few other states soon followed, notably Connecticut, Maryland and California; and a number of others, which did not assume full responsibility for building the system, required that the state-aid funds be expended upon a definite plan of routes connecting the population centers throughout each state.

The Modern Period

The year 1916 marks the real renewal of federal highway legislation after a lapse of approximately a century. This legislation provided the very important principle that, in order to qualify for participation, a state must establish a state highway department adequate to carry the direct responsibility for the expenditure of the combined state and federal funds. It also provided that the states should each accept through legislative action the



COMPARISON OF EXPENDITURES FOR NEW MOTOR VEHICLES AND FOR HIGHWAYS BY YEARS

terms and conditions established. Thus, immediately following 1916, the state legislature of each state enacted and in general extended state highway legislation. It marked the beginning on a national scale of modern highway legislation.

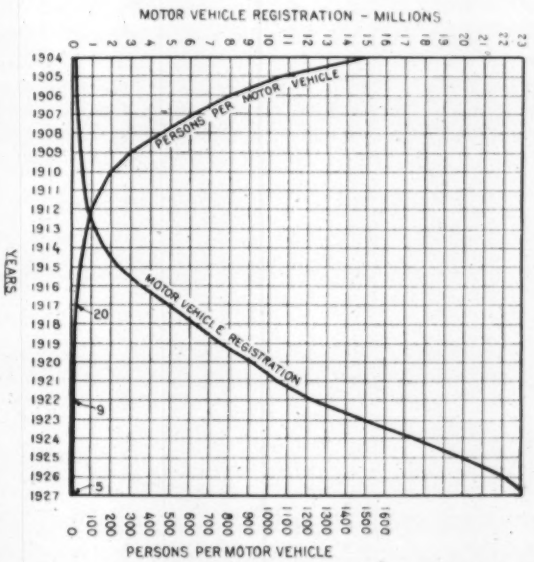
In 1921 a new federal law amending the former act was passed, providing in much greater detail the principles on which federal participation would be extended. The most important of the new principles was the provision for the laying out of a system of highways, interstate and intercounty in character, to consist of not more than 7 per cent of the total highway mileage of each state. By co-operation among the states themselves and between the states and the Bureau of Public Roads, a

system of roads was laid out so co-ordinated as to form a national system of 170,000 miles, to which additions have been made so that at the present date it totals 188,000 miles. There are 105,000 miles more under jurisdiction of the state highway departments.

The next important step came through the request of the American Association of State Highway Officials to the Secretary of Agriculture to appoint a committee representative of the state and federal highway organizations to determine and select a system of through routes. As a result of the work of this committee there was set up a system named by action of the states "The United States Highway System," including 96,000 miles of interstate routes. A complete code of warning and directional signs has also been established and has been put into general use throughout the United States by the state highway departments.

Credit to the Engineer

Many conclusions might be drawn covering the development outlined, but taken from the standpoint of the engineer perhaps these are of greatest interest: (1) We cannot take credit in the United States for the development of any new type of construction up to the building of the first concrete road in 1893 in Bellefontaine, Ohio. (2) The engineers of the United States can take credit for the development of the concrete road up to its present standard of perfection and for the control of materials and the mechanical processes and equipment which today make possible a higher rate of production of this type with less hand labor than any other type of construction. (3) The profession can also take credit for the development of methods of construction, maintenance, utilization of local materials and bituminous processes that are serving traffic, not always in *de luxe* manner, to be sure, but in such a way as to meet a tremendous problem. (4) It can also take credit for instituting programs of research of rapidly growing dimensions in both the physical and economic fields. (5) Probably more of the existing legislation, state and federal, has been written by engineers than applies to any other public activity.



MOTOR VEHICLE REGISTRATION AND PERSONS PER VEHICLE BY YEARS

Looking to the future, what lies ahead of us? There is just now a considerable amount of highly superficial agitation and propaganda for this and that in the way of future highway development. There is just one principle discoverable that runs constant throughout our history of road development, and that is to build the roads on the basis of serving the required utilization of the vehicle with economy. This is the one sure guide.

Without discussing or arguing the situation, a correct application of the measurable, through research, utility of the motor vehicle will very quickly point out the fallacies in many advocated plans of improvement. The most fallacious of these plans originates in the congestion now existing in metropolitan areas, which traffic is assumed to continue in unbroken numbers from end to end of the continent, thus necessitating great continental routes within metropolitan areas and closely connected large centers of population. The really big problem is today the same as it has been since the first settlement at Jamestown: To facilitate this most intimate type of transportation by means of roads which are capable of carrying the vehicle with economy for the greatest possible number of people.

Study Concrete and Concrete Aggregates

MORE than 60 prominent engineers who make up committee C-9 of the American Society for Testing Materials are engaged in carrying out an unusually full program of work for the coming year. The committee is subdivided into seventeen sub-committees, to each of which is assigned several specific problems dealing with the various phases of concrete and concrete aggregates. Among the more important projects being considered are the following:

Specification for mixing, conveying and placing concrete.
Design of concrete for flexural strength.
Standardization of transverse strength tests.
Apparatus for measuring workability.
Methods of making abrasion tests.
Relation of shape of aggregate particle to cross-bending and compressive strength.
Stone and slag sand as a fine aggregate.
Effect of foreign materials.
Curing.
Admixtures.
Apparatus and methods of testing for deformations.
Durability of concrete.
Nomenclature.

It is expected that the committee will present definite reports of progress on all of the projects listed, as well as on several other important subjects, at the next meeting of the society.

Regional Planning Spreads to Small Towns

THAT small communities, as well as the larger cities, may benefit from joint action in the solution of engineering problems has recently been illustrated at Camp Hill and New Cumberland, two towns on the west side of the Susquehanna River opposite Harrisburg, Pa. The problems which united these two communities are the usual ones which first force regional consciousness: sanitary disposal of sewage, street connections, health and transport facilities. Francis J. Mulvihill, chief of the division of city planning and municipal engineering of the Pennsylvania Bureau of Municipal Affairs, states that this is the first case of regional planning on the part of smaller communities in Pennsylvania, although regional work has already been done around Philadelphia, Pittsburgh and Washington.

A Graphic Record of Highway Growth

Approximately 20 Per Cent of National Mileage Surfaced—Yearly Expenditures Nearly a Billion and a Half—Amount of Improved Roads Increased 55 Per Cent Since 1921

THE steady growth of improved highway mileages in the past six years, together with the corresponding increase in expenditures and the classification of types, both national and by states, are shown in the four accompanying charts. These are based on data compiled from official records of the U. S. Bureau of Public Roads. Prior to 1921 few data are available for comparison purposes, except for a few scattering reports.

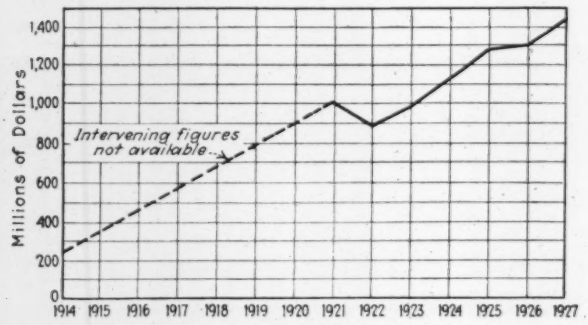


FIG. 1—TREND OF ANNUAL ROADBUILDING EXPENDITURES
Figures show amounts spent each year and not totals to date.

At the beginning of 1928 there were 3,013,584 miles of highway in the country. Of this amount about one-fifth, or 588,722 miles, was improved beyond the dirt-road stage.

The increasing trend of road expenditures by years for the whole country is shown in Fig. 1. This chart does not represent the investment to date, but indicates the amount spent annually from 1914 to 1928. Early records show that in 1904 the year's total of highway expenditures was only $79,623,617. In 1914 more than three times as much, or nearly a quarter billion dollars, was spent, while in 1927 a billion and a half dollars went into the highways of the nation.

The classification of the improved and unimproved mileage and the relative amounts of different types of surfaces used are shown in the circle diagram Fig. 2. Considering the 589,000 miles of improved roads, about 15 per cent are surfaced with sand or clay; 73 per cent with treated and untreated gravel, chert, crushed stone and waterbound macadam; and the remaining 12 per cent with hard surface of higher type.

Fig. 3 exhibits the total mileages of different types of surfaced roads existing at the end of each year from 1922 to 1927.

State highway mileages classified according to surface existing at the end of 1927 are shown in Fig. 4. The unimproved mileages include all public lands designated for roads, regardless of whether roads actually exist.

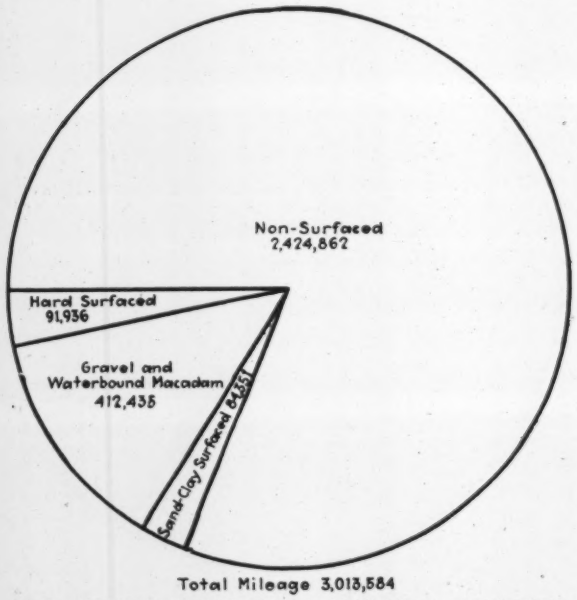


FIG. 2—CLASSIFICATION OF NATIONAL HIGHWAY MILEAGE
Hard surface includes penetration macadam, bituminous concrete, sheet asphalt, brick, block and concrete pavements. Fig. 4 shows this classification of surfaces by states.

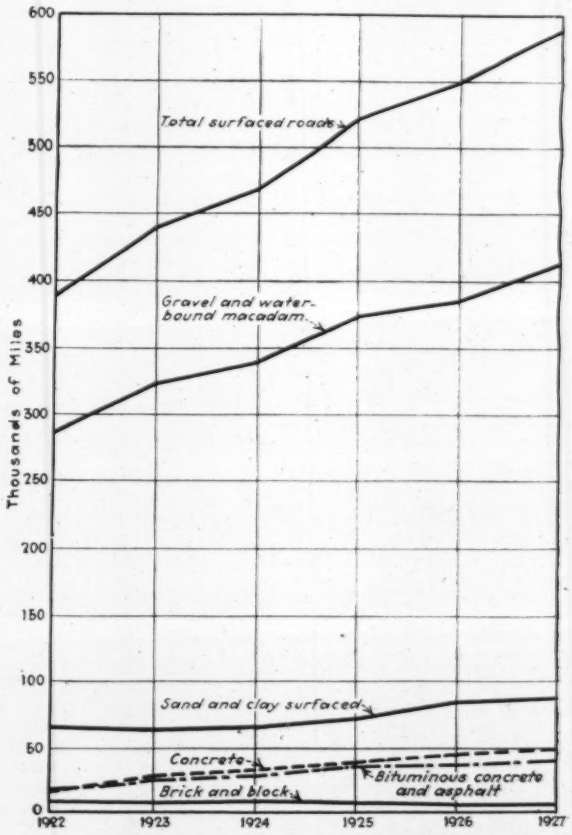


FIG. 3—CLASSIFICATION OF SURFACED MILEAGE
Total amounts of different types of surface shown at end of each year from 1922 to 1927 (1922 figures taken at first of year).

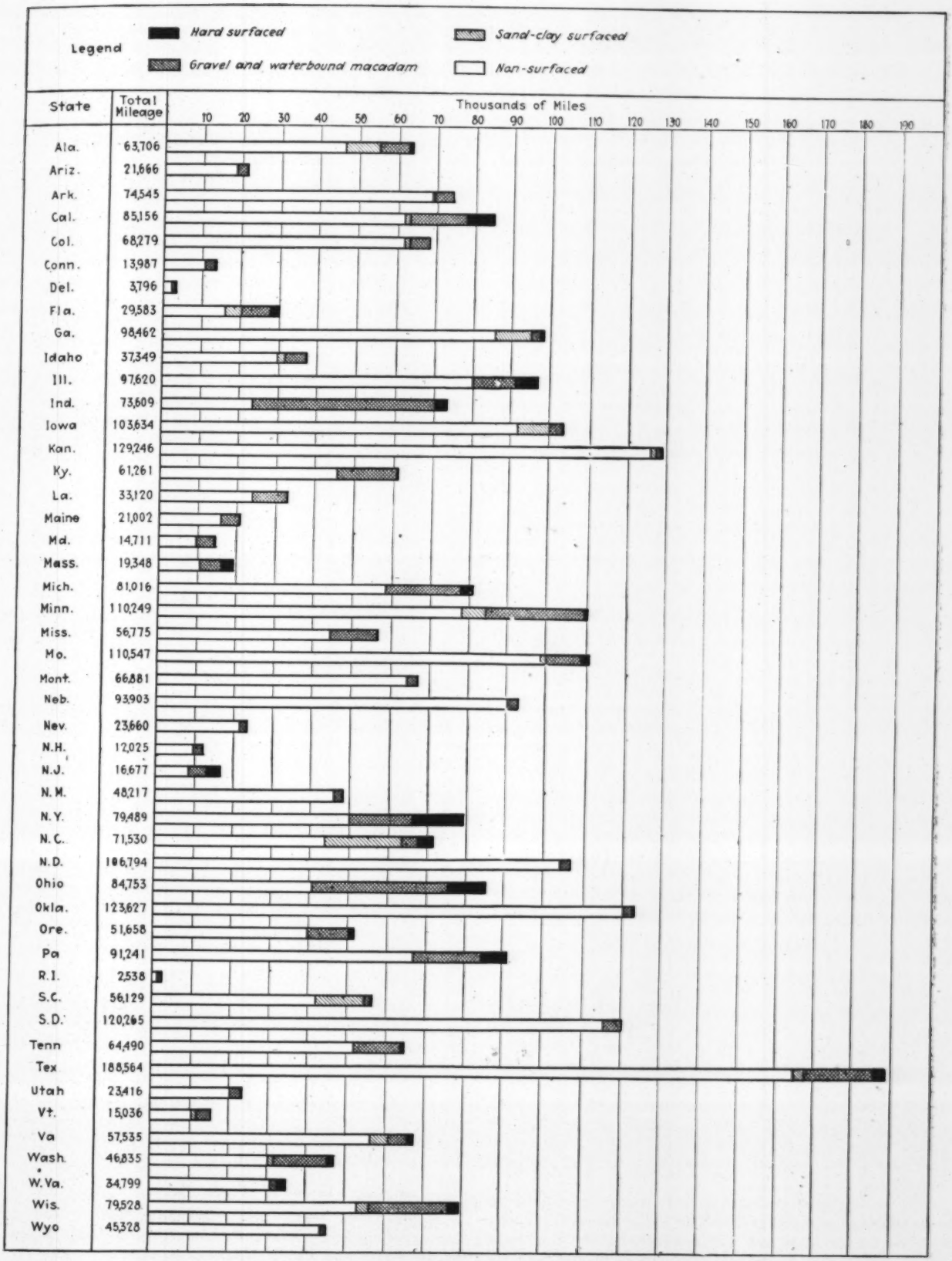


FIG. 4—HIGHWAY MILEAGE BY STATES CLASSIFIED ACCORDING TO SURFACES

Low grade—sand and clay surfaced; medium grade—treated and untreated gravel, chert, crushed stone and waterbound macadam; high grade—penetration macadam, bituminous concrete, brick and block and concrete pavements.

What We Know of Traffic
And What It Foretells

Highway Departments Must Establish Definite Five- and Ten-Year Improvement Program and Complete Traffic Surveys to Enable Scientific Policies of Future Highway Improvement to Be Framed

By J. Gordon McKay

Director, Cleveland Highway Research Bureau, Cleveland, Ohio
Formerly Chief, Division of Highway Economics, U. S. Bureau of Public Roads

THE past twenty years have seen the re-emergence of highway transportation from a position of unimportance to a place of major importance in our national scheme of transportation. The registration of 23,500,000 motor vehicles in the United States in 1927, compared with 5,000,000 in 1917, illustrates the rapid growth in motor-vehicle ownership and a corresponding increase in traffic use of the highways. The public demand for highway improvements for motor-vehicle use explains the sharp increase of expenditures during the past ten years until today highway-improvement costs have become one of the principal items of public expenditure.

In 1927 the rural highways of the United States cost $1,300,000,000, half of which was used for the improvement of state highways and the remainder for local roads; in 1917 the cost was $232,600,000, of which one-fifth was expended on state highways and the remainder on local roads. This large yearly expenditure demands careful consideration of the character and usefulness of the resulting highway improvements and of the soundness of present improvement policies. It also warrants establishing scientific policies of future highway improvement based on traffic and engineering studies.

Lack of scientific method characterizes the improvement and development of highway systems. Location of road improvements, their relative precedence and their nature have been little better than educated guesswork. It is marvelous how exact the guessing has been, but the time has arrived for calculated planning to supersede it. No highway engineer questions the fact—he merely lacks decision as to what can or should be done. Properly interpreted, traffic survey findings go far toward telling him. Mr. McKay in this article interprets the half-score of traffic surveys made by state and national co-operation during the last five years. As an adviser and director in all these surveys he speaks with knowledge had by few others. His article is notable in its field for keen analysis and constructive teaching.

Highway Development Eras

The development of highway systems in the United States can be grouped in three major stages:

1. The early period of local control, with its inevitable evils of waste of public funds, inadequate construction, inefficient construction methods and a failure to development connected systems of satisfactorily improved roads.

2. The period of state and national control, characterized, in the main, by greatly improved engineering standards and construction methods, which are resulting in more satisfactory improvements and the development of connected systems of improved state and national highways.

3. The present period, typified by the emergence of the highway regional area, which is the zone of intensive highway utilization and within which will be found the most complicated traffic and engineering problems of the future. The present period is also characterized by a new highway improvement policy involving the development of national, state and regional highway systems based on scientific analysis of traffic and engineering facts.

Highway systems should provide satisfactory transportation by the most direct, practicable routes between the various sources of traffic in a given area. Streets and highways must be so planned and constructed as to provide satisfactory facilities for the efficient and economical distribution of traffic. Any other use of the street or highway is secondary in importance and should be treated only after the major purpose has been met.

The expenditure of public funds for the improvement of the several classes of highways, the character of these improvements and their location in the several sections of a state or regional area should be based, primarily, on the traffic that now travels, and during the next fifteen or twenty years is expected to travel, on the major arterial routes within city limits and on state, county and township highways.

There is no fundamental difference in principle between the public business of developing systems of improved highways and private or quasi-public enterprises engaged in producing services or commodities. Both classes of industries supply their commodities or services based on the demand for their product. The outstanding difference between these two industries is that private or quasi-public businesses base the expansion of their capital investment and production on demand, as determined by analysis of facts. The highway industry, on the other hand, has generally neglected this type of analysis, which should be the basis of its program of improvement over a period of years. In the main, the attention of highway authorities has been directed toward the analysis of the physical aspects of highway engineering, and comparatively little attention has been devoted to the analysis of traffic facts, which, as a general rule, should determine the character of the improvement of city streets, national, state, regional and local highways.

Lessons of Traffic Surveys

Motor-vehicle traffic and engineering facts obtained from the highway traffic and planning surveys completed by the Bureau of Public Roads in co-operation with the several state and county highway departments in California, Connecticut, Maine, New Hampshire, Ohio, Pennsylvania and Vermont and in the Chicago and

Cleveland regional areas, show that traffic use and distribution on the highway systems of these areas have similar characteristics. Traffic, administrative, financial and engineering studies completed in these states and in the regional areas warrant the following conclusions:

I. Lack of scientific methods in planning the improvement and development of highway systems.

1. Main arterial city streets and state and county highway systems, in general, have not been improved on the basis of highway traffic and engineering facts.

2. Officials responsible for these improvements have failed, except in a few cases, to establish definite highway policies and programs of improvements for a period of years based on facts.

3. The amount of street and highway improvement expenditures has been determined, primarily, by available income, rather than on a definite program of construction based on traffic demand.

II. The relation between traffic use and highway improvements.

1. Rural highways have not been improved in the order of their traffic importance.

2. The volume of highway traffic and its character, composition and distribution on main arterial and local city streets and on state, county and township roads is materially different, and the improvement of these various classes of roads and streets should be in accordance with their traffic importance.

3. The most important sections of national, state and county highways are located in the regional traffic zones, which are the important centers of traffic and population.

4. National, state and county highways converge and unite as they approach centers of population, concentrating traffic on a few main routes and creating serious traffic congestion problems.

5. The demand for highway service has increased more rapidly than the provision of improved surfaces, particularly in the regional traffic areas.

6. Traffic congestion on the streets and highways of the regional traffic areas is due principally to four major causes: inadequate surface width; the absence of sufficient arterial highways; use of the roadway surface for purposes other than the movement of traffic, such as street-car lines, street-car loading platforms, and parking at the curb; and intersecting main traffic routes.

7. Long-distance traffic of trips in excess of 60 miles is small in volume. Traffic facts supporting the improvement of highway systems show clearly that local traffic forms a large part of total traffic except on the main routes of the few important tourist areas, and is the primary basis for highway improvement programs.

8. Traffic on the rural highway system is predominantly that of city-owned passenger cars and motor trucks.

9. The planning and construction of highway surfaces on a large mileage of state highway systems to serve motor trucks in excess of 2½ tons capacity are not supported on the basis of either present or expected future motor truck use.

III. The relation between traffic use and the type of highway improvement.

1. The improvement of rural highways with a major traffic surface (concrete, brick or their equivalent), a medium traffic surface (bituminous macadam or its equivalent) or with a minor traffic surface (gravel or its equivalent) has not been determined, in general, by a factual analysis of the present and expected future use of each section of the highway system.

2. The determination of the types of surface for any section of a highway system depends, primarily, upon the daily volume of present and probable future traffic, modified by the several physical problems involved which frequently influence the selection of types of improvements. Based on average daily traffic during the summer period, a highway which now carries or within ten years will carry approximately 1,800 or more vehicles daily should be improved with a major traffic type (concrete, brick or their equivalent). Those sections which now carry or in ten years will carry between approximately 700 and 1,800 vehicles a day should be improved with a medium traffic type (bituminous macadam or its equivalent). Sections of the system on which daily traffic will not exceed approximately 700 vehicles a day within a ten-year period should be improved with a minor traffic type (gravel or its equivalent).

3. The present and probable future traffic use of rural highways during the next ten-year period does not require the construction of major traffic surfaces (brick, concrete or their equivalent) on more than 5 per cent of the total rural highway mileage of the United States.

4. Highway improvements, in excess of an "all-weather" road surface, have a comparatively small influence on the value of strictly rural land.

IV. Traffic density, distribution and roadway capacity in relation to surface width and highway right-of-way.

1. The provision of new two- or four-lane arterial routes is a more satisfactory solution of traffic congestion, primarily in the regional traffic zones, and provides more satisfactory distribution of traffic than the widening and surfacing of existing routes in excess of four free traffic lanes.

2. Traffic volume on state highway systems during the next fifteen years, except in the regional areas, will not require the construction of surfaces of more than 20 ft. for the movement of traffic.

3. Highway surface widths in excess of two lanes, 20 ft., and less than four lanes are unecomonic. The three-lane surface is usually a compromise improvement where there exists a peak load movement of traffic and where acquisition of additional right-of-way is impractical.

4. Surfaces in excess of four lanes, approximately 40 ft., for the free movement of traffic are unnecessary even in the regional areas.

5. Double pavements, with a center parkway, do not have a greater traffic capacity than a unit surface of equal width, but require additional right-of-way and increase construction and property damage costs.

6. The acquisition of highway right-of-way in excess of 60 ft. on a large mileage of state highways is unwarranted except in the regional traffic areas. Building setback lines should be established to preserve highway right-of-way for future acquisition when necessary.

7. Street-car operation and vehicle parking are not highway functions, and two- or four-lane surfaces should be constructed exclusive of the surface used for these purposes.

V. Legislative or constitutional provisions have, in many cases, hampered the development of highway systems.

1. Routes comprising state highway systems have not been selected on the basis of their traffic importance. As a result, these systems frequently contain a considerable

mileage of roads of low traffic density, while a comparatively small mileage of the heavy traffic roads in regional areas are state routes.

2. Highway funds have, in many areas, been allocated to the various jurisdictions responsible for highway improvements without consideration of the relative traffic importance of the highway systems of the section or the necessity for their improvement.

3. Control over the improvement of main traffic highways has, in many areas, been partly delegated to local jurisdictions. Such procedure is unwarranted based on the volume and character of traffic using these routes.

A Traffic Classification of Highway Systems

Based on traffic use and traffic characteristics in regional and rural traffic zones, the following items of jurisdictional, planning, construction and maintenance control over highway systems are suggested.

1. State highway systems: State systems, as a general rule, comprise the important traffic routes of a state. The improvement of this system is made necessary, primarily, by the large volume of city-owned motor-vehicle traffic operating on state highways. The state should have complete control over the planning, financing, construction and maintenance of state highways.

2. Regional highway systems: Regional highway systems comprise the highways within and adjacent to the centers of population. These regions are the principal traffic areas of a state and therefore include the most important sections of state and county highways that require improvement. Unified control over the planning, financing, construction and maintenance of regional highway systems should be established by enabling legislation. The area should include the suburban counties which are located within the traffic influence of the principal population centers.

3. Regional rural highway systems: Rural highways, exclusive of those routes included in the state system and located within regional areas, are relatively unimportant as to their present and probable future traffic use and are essentially local roads. Counties similar in development and in traffic characteristics should be grouped under one construction and financing jurisdiction. Control over the improvement of rural regional highways should be established by enabling legislation.

The Highway Traffic and Engineering Planning Survey of State and County Highway Systems

Highway traffic and engineering surveys of state or county highway systems are of little value unless, as a result of the analysis, a constructive program of highway improvements based on traffic and engineering facts is planned for development over a period of years and the highway system is improved in accordance with the plan.

The plan of highway improvement should be developed from the following general classes of evidence.

1. Present highway traffic: The daily volume of passenger car, truck and bus traffic on each section of the highway system should be determined; a forecast of probable future traffic for periods of five, ten and fifteen years should be made for each section of the highway system, and the various sections of the system classified as major traffic routes requiring high-type improvements, medium traffic routes requiring medium-type improvements, or minor traffic routes requiring minor-type improvements.

2 The distribution of highway traffic: The origin and destination of traffic operating among the various sections of an area, particularly in the regional areas of dense traffic utilization, is essential to determine the necessity for the construction of new routes or connections and is basic evidence supporting the development of new arterial routes.

3. The present condition and estimated life period of existing surfaces: Each section of the highway system should be inspected, analyzed and classified as satisfactory for a given period of years, salvable as sub-base in place, salvable as material, or of no value for reconstruction purposes.

4. Classification of structures: Bridges should be classified as satisfactory, requiring replacement, or in need of widening. Railroad grade crossings should be classified either as requiring separation or the installation of modern methods of warning for the protection of traffic. Highway intersections should be classified as requiring separation, traffic control or the method best adapted to the volume and character of traffic on the intersecting routes.

5. Surface width: The traffic capacity of various surface widths should be ascertained, based on the discharge capacity of various widths and studies of the transverse distribution of traffic, to determine the sections of the highway system which will require surface width in excess of two lanes of traffic.

6. The present type, width of surface and width of right-of-way for each section of the highway system.

7. Studies of the density, distribution and trend of population and industrial growth in the cities and their suburban areas.

8. Analysis of arterial, lateral, belt and bypass routes, relocation of sections of highways, unimproved gaps in the present system, time studies of traffic and train movement at railroad grade crossings and topographic and hydrographic surveys.

9. Detailed analysis of the cost of construction as a basis for estimating the cost of the planned improvements and determination of the budget. Evidence of this type, supplemented by other minor types of information, is essential to the determination of a sound program of highway improvement. The improvement of specific sections of a highway program is modified by physical studies and conditions which, in many cases, influence the character of an improvement.

Improvement Programs Essential

The several highway departments responsible for the improvement of highways within their jurisdiction should be required to establish definite programs of improvement over a period of five to ten years prior to the investment of public funds.

State highway departments and the authorities responsible for highway improvements in regional areas should establish highway planning departments as an important part of the highway administrative organization.

In the several states and the regional areas, where state traffic and planning surveys have been completed, the program of highway improvement, based on traffic and engineering facts, is, in general, being carried out. In the Cleveland regional area, where a thorough traffic and engineering planning survey was completed in 1928, the cities, counties and villages of the area have agreed to complete the "Plan of Improvement," and the 1929 program of improvement is based on the plan developed from the traffic and engineering facts of the survey.

Money for Roads

Six Sources of Increased Funds, Mainly Greater Use of Gasoline Tax and Bond Issues, General Property Taxes and Special Assessments

By T. R. Agg

Professor of Highway Engineering, Iowa State College, Ames, Iowa

AN ESTIMATE of the extent to which average annual expenditures for highway improvement must increase is a hazardous prophecy, but that they must increase seems perfectly apparent. The writer believes that the average annual expenditure for highway improvement during the next fifteen years will of necessity be at least double that of 1928. The financial problem imposed in financing such an expansion of the highway-construction program merits painstaking research, comparable with that which has been brought to bear upon the engineering problems involved in the construction of roadway surfaces. It is quite apparent, however, that some states are pursuing a purely hand-to-mouth policy with reference to finance, following the lines of least resistance in securing funds.

A survey of the status of highway improvement at the close of 1928 will reveal that in spite of the great road-construction programs of recent years not more than half the states have as yet gained on the requirements in the way of traffic capacity to meet the astounding expansion of the use of the highways for transporting goods and persons. In some states programs of improvement were undertaken a few years ago that were believed to provide a margin of capacity to take care of years of expansion of use; it now appears that use has increased at a faster rate than has the increase in road capacity. With the original program of construction well along toward completion, those states find that traffic congestion is worse than when their program was begun and they face the necessity of accelerating the construction of additional traffic capacity of widening existing pavements and paving additional routes. The method of financing this future construction by states heavily burdened with the cost of present improvements is an immediate and a difficult problem. The present article attacks the problem boldly and merits close study.

Fundamental Principles

The number of variables in the problem of finance is so great that an attempt to evaluate each leads to bewilderment, and the possibility of arriving at any rational solution appears hopeless. But it is imperative that highway finance be continued and expanded on a sound basis; the longer it is delayed the greater will be the difficulties when economic pressure forces action. After all, the problem resolves itself into a few acceptable forms of taxation, most of which are already used by a number of states. An attempt will therefore be made to sketch some of the fundamental conceptions of a system of highway finance and their application to revenue systems.

The imposition of a highway tax of any kind should be based on a consideration of the following factors:

1. The magnitude, distribution and nature of the benefits that accrue from road improvement.
2. The equity of the system among the taxpaying units affected.
3. The ability of the taxpaying units to meet the impost without being subjected to economic distress.

Benefits—Three classes of benefits are recognized as growing out of road improvement.

General benefits: This is a totally inadequate designation for those benefits that are reflected in the social, commercial and educational stimulation afforded by an increase in the facility with which persons and goods may be transported. Such benefits first manifest themselves locally but flow out along the lines of commerce and combine with the effects from other local sources to become of tremendous national importance.

Special benefits to land: Highway improvement may, and frequently does, confer a special benefit to lands lying within a zone adjacent to the improvement. The eventuation of such a benefit depends, first, upon the nature of the highway improvement, and second, upon the capacity of the land to respond to the stimulation of the particular highway improvement. Benefits of this type cannot be measured by a general land tax.

Special benefits to traffic: The benefits to traffic are of two types. One results from the fact that improved roads exist in an area ready to serve any traffic that chooses to use any particular improved highway. The other is the benefit in the form of lowered operating costs and business advantages that accrue to those who actually use a particular improved highway.

Equity — Having decided that a certain class of benefits serves as a justification for any form of highway tax, it remains to adjust the method of application of the tax so that imposts will be equitable. In effect one must answer the following question in the affirmative before approving any system of highway taxation: Do all taxpaying units contribute on substantially the same basis of assumed rate or intensity of benefit? Generally the problem presents itself in some such form as this: Is the gas tax equally fair to buses and to trucks? Or, is the basis for assessing the vehicle license fee equitable as among vehicles of various sizes, prices and classes?

Ability to Pay—It seems to be recognized that in raising revenue for highway improvement, as in schemes for other forms of taxation, it is proper to take account of relative ability to pay on the part of taxpaying units, whether they be individuals or corporate entities. This is well exemplified in the general case by the graduated income tax and in highway taxation by the portion of the motor vehicle license fee which is based on the list price of the vehicle. Obviously any such plan must be equitable among units of like ability so far as it is possible.

While it is fairly easy to state the principles of taxation that should govern the provisions for revenue for highway improvement, the application thereof is by no means simple. Especially is it true that in seeking methods for increasing the income of highway departments to meet the needs of the next fifteen years there will be great reluctance to employ some of the methods that seem to be indicated by an application of the principles involved. Some of these will be discussed briefly.

Application of Principles

Revenues Based on General Benefits—General benefits are intangible and illusive. They are but poorly understood by any, and are wholly unappreciated by the public. They shift about from area to area with changing economic conditions and the state of highway development in the areas. The only way they can be reached is by general taxation. But if general taxation in any area means primarily taxation of real property, a great mass of value escapes taxation and too great a part of the burden is thrown on real property. General taxation spread over small political units such as the county or subdivisions thereof does not achieve the desired result, because concentration of wealth in the cities very largely escapes. Taxation spread over a state is satisfactory so far as distribution is concerned, but it may place too heavy a burden on real property. Where state revenues are obtained from income, corporation, inheritance and similar taxes, as well as from property taxes, state taxes for highway improvement reach the recipients of general benefits. If the state has an up-to-date system of assessment of property and a modern tax system, a state road tax is equitable, is in accordance with benefits and ability to pay and may be justified on the basis of general benefits.

In some states the vehicle license fee is assessed in lieu of any other tax on the vehicle—that is, the vehicle is not assessed for general taxation. This is in effect levying a general state tax for road improvement, but it is paid by one class of citizens only, those who own vehicles subject to the law.

General benefits are of more than of state-wide import and therefore justify the application of federal funds to highway improvement. These funds are obtained from forms of taxation that reach taxpaying units that are peculiarly affected by general benefits from highway improvement because the taxpaying ability of these units fluctuates with the general prosperity of the nation. Highway improvement is one factor affecting such prosperity.

It is conceded that land should contribute to road funds because the owners of the land, in general, participate in any general benefits that follow road improvement. It is not readily appreciated that road improvement remote from a given parcel of land has any influence on the prosperity of the owner of that land. But suppose that Cleveland, Ohio, is prosperous and that part of that prosperity is traceable to the state of highway improvement in the vicinity thereof or elsewhere. Commodities from Iowa farms find their way to Cleveland, and thus Iowa land receives an indirect but nevertheless real general benefit from road improvement in some remote place. The land should therefore contribute its part toward funds based on general benefits, and a general tax is the only means of securing such a contribution.

Revenues Based on Special Benefits to Land—Road improvement in the immediate vicinity of a parcel of land may confer a direct and measurable benefit on that land. This benefit may be so small that it is not worth while to try to reach it through taxation or it may be so great as to increase the actual sale value of the land very materially. In the latter event the benefit should be the basis of highway revenue which can be obtained equitably only through the application of special assessments. These must be made on a basis of the exact conditions surrounding the particular project involved. In some instances this special benefit can best be reached through the application of the process known as excess condemnation. The legality of this method is under a cloud at present; it is unconstitutional in many states. It does deserve serious consideration in connection with certain types of highway improvements.

It may be proper to mention in this connection that the effect of trunk highway construction upon farm land values has generally been much smaller than is often assumed.

If special benefits to land are correctly assessed, they are equitable and in accordance with ability to pay.

Revenues Based on Benefits to Traffic—The benefit received by traffic in the form of lowered cost of operation and greater mobility that follows road improvement is justification for imposing upon traffic a tax that is proportional to the extent each vehicle uses the highway. The prospective benefit to traffic that arises out of the fact that improved highways have been provided ready for use when desired is justification for a readiness-to-serve type of tax to be paid on the same basis by all vehicles regardless of the extent to which the roads will actually be used by the vehicle.

The use tax should be in a form that will be strictly proportional to the use of the road—that is, to the miles of travel and the weight carried.

The readiness-to-serve tax should be based on the weight of vehicle for which provision had to be made and to the cost of the vehicle, if it is desired to vary this charge with ability to pay.

The gasoline tax is a satisfactory means of securing funds in proportion to road use so far as automobiles are concerned. It is in accordance with benefits and is equitable as among individuals. It does no violence to the theory that ability to pay may be considered in fixing a tax. It is not equitable as between commercial vehicles and automobiles, although the disparity is small except that the heavier commercial vehicles (say those above 2 tons capacity or 4 tons gross weight) are favored rather markedly. For the heavier commercial vehicles the gasoline tax should be supplemented by some form of mileage tax. In the case of common carrier vehicles, the gross profits tax might be substituted for the mileage tax.

The registration fee is a satisfactory means of applying a readiness-to-serve tax, provided the basis is fixed so as to take account of the relative investments in roads made necessary by each weight of vehicle. Such a fee is in accordance with benefits that are clearly apparent, it can be established on a basis that is equitable between individual tax-paying units and may be adjusted to take account of ability to pay.

Financing Maintenance

There is reason to doubt the wisdom of thinking of road improvements in terms of construction operations and maintenance operations when dealing with financial problems. These two types of activity combine to constitute what might be termed highway maintenance, using

the term maintenance in its broader meaning. If that is done, the cost of maintenance includes all expenditures required to keep the roadway in suitable condition for its traffic. This total cost should be met with funds obtained from the following sources:

1. General state and county taxes levied on the basis of assumed general benefits to the commonwealth. The present township taxes should be consolidated with the county tax and be supplemented by state funds to be expended according to the needs of traffic on all parts of the local highway system. This tax is to produce all of the revenue to be used on the local roads.

2. Federal funds allotted as at present but in greatly increased amounts. These funds are obtained by methods of taxation that, more nearly than any other, tap the accumulations of wealth that have resulted from the general benefits due to internal improvements in the country. These taxes are equitable and to a marked degree comply with the principle of ability to pay. This allotment is to produce about 25 per cent of the funds required for the state and interstate highways.

3. Vehicle license fees, mileage or gross profits on operation taxes, and the use tax in the form of the gasoline tax. Of the total revenue to be secured from these funds, one-half is to be provided by the gasoline tax, which should in no case exceed 5 cents per gallon, plus the mileage or gross profits tax. These taxes are to provide 75 per cent of the funds used on the state and interstate highways and to be used for no other purpose.

4. Special assessments or income from excess condemnation. Unimportant in the aggregate amount but necessary in connection with some types of improvement.

Bonds Justifiable

The anticipation of future revenues through the issuance of bonds is justifiable for any capital expenditure of an enduring nature that promises to yield returns commensurate with the interest cost incidental to the issuance of bonds.

It seems quite clear that for many years it will be necessary for states to continue to issue bonds to secure funds for investment in roads. If the administration is efficient, this method of providing funds is equitable, proper and advisable. It is merely the adaptation of good business methods to a very urgent public enterprise. Obviously the proceeds of the sale of bonds should not be used for routine repairs on road surfaces. But the bond method of financing is certain to be the key to the problem of working out the present inadequacies of the highway systems of the states. In most cases the use of current funds will not permit sufficiently rapid progress to catch up with the needs of traffic, and meanwhile routine repair costs will absorb a totally disproportionate share of the income.

Incidentally, bonds really provide the only means whereby a pay-as-you-go policy can be established. If current funds are used it is a case of pay-before-you-go.

Changes in Administration Required

The problem of financing cannot be divorced from that of administration, because the financial requirements of the next fifteen years cannot be met if the taxpaying public is not assured that money is being expended wisely and efficiently. In such a program as it must be carried out, advantage must be taken of every economy in construction that research has developed. This is impossible unless the administration rests in the hands of officials of sufficient breadth of vision and experience to inaugurate the correct policies and to see that they are carried through.

Legislative Trends

The trend of legislation in recent years in the United States has been toward the centralization of authority over many public enterprises in the state or federal government. A great many sincere people entertain serious misgivings as to the advisability of the delegation of any considerable amount of authority to appointive boards and departmental bureaus, thereby circumscribing the powers of local elective officers. There may some day be a reaction to this present trend in government, but those who are conversant with the events of the past 30 years in the field of highway administration know that there has been marked improvement in highway management accompanying the establishment of the state highway departments and the federal Bureau of Public Roads. This despite the fact that certain objectionable practices have grown up along with the rapid centralization of highway authority.

The division of the highways of a state into "systems" is illogical, although convenient from the administrative and legislative standpoint. The time has arrived when the township and the sub-district should fade from the picture as road-administration units. They are inherently wasteful and extravagant and cannot keep pace with the trend of the times in road-construction methods. A strictly modern highway bridge, or a really high-grade pavement, that has been constructed entirely under either county or township supervision is rarely encountered, although there are a few outstanding exceptions.

The county administration should be closely synchronized with state administration if not actually constituted a subordinate organization thereunder. Financial control should extend from the state to all subordinate divisions of the highway system, through appropriate budgeting and reporting methods supervised by the state.

Summary and Forecast

1. It is estimated that average expenditures for highway improvement during the next fifteen years will be at least double those of 1928.

2. It is suggested that the increased funds be obtained from the following sources:

- **(a) Increased federal aid.**
- **(b) Increased taxes on the heavier vehicles that make up highway traffic.**
- **(c) Increase in the gas tax with 5c. per gallon the maximum, and restriction of the gas tax fund to the state and interstate roads.**
- **(d) State taxes to supplement local taxes for local highways (in lieu of a distribution of gas tax, etc.).**
- **(e) Increase of use of bonds, these to be retired after the highway systems have reached the stage where new construction will decline.**
- **(f) Use of special assessments and excess condemnation where marked increases in property values will result from improvement projects.**

3. Administrative reforms are suggested in the interest of better use of funds:

- **(a) The elimination of the township and the sub-district as highway administrative units.**
- **(b) Close correlation between the state and the county highway administration, through use of state funds to supplement local funds.**

How Road Types May Be Improved

A Symposium

Five Articles That Indicate the Progress Made and Improvements Foreseen in the Structure and Construction of Concrete, Asphalt, Brick, Gravel and Stone Roads

HOW well are the prevailing road types fitted to serve future road development? Classified according to primary material, they are concrete, brick, asphalt, gravel and stone. While these materials in practice are associated in various combinations, they have clear distinction as road types. Each has improved as the demands of the vehicle using them have changed and increased. What is their present capacity to meet this demand? Can they be further developed to meet different and more exacting demands?

These questions are vital as we look forward to a more scientifically intensive era of highway improvement. The answers as they are comprehended by the technicians of the associations which each of the interests has organized to advance its service are given in the five articles which follow. These articles in no manner pretend to cover and embrace their subject. They are brief presentations of the high lights of progress and promise. In each case these are different. In all the fact appears that a forward-looking attitude of mind exists. There is no inclination to accept the present accomplishment as final. Instead there is confident assertion that improvement and advance are certain.

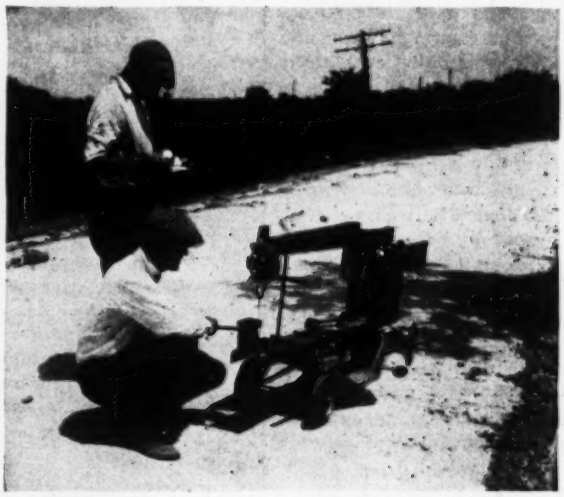
Concrete Roads

By L. S. Trainor

Manager, Highways and Municipal Bureau, Portland Cement Association, Chicago

CONSTANTLY advancing technique of design and construction guarantees the fitness of the concrete road to meet future traffic demands. As a structure it is stronger and more logically designed each year. Each year the precision of machine production is increasing its service value. The details of advancing improvement are many, and only those which stand out as a guarantee of future adequacy of concrete roadbuilding technique to the demands of traffic can be considered.

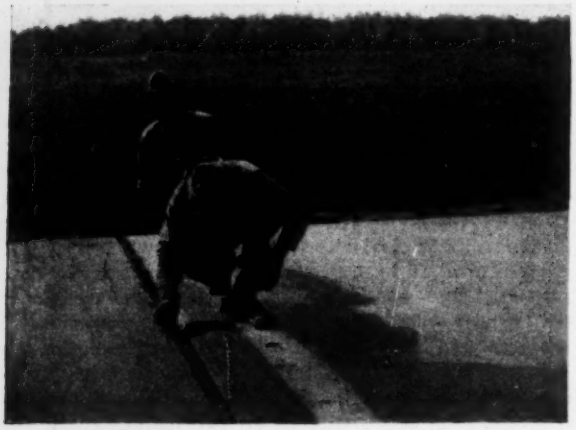
Better Surfaces—From the road users' standpoint the most important advance is in riding quality. Beginning with slabs on which bumps ½ in. high were of little consequence, construction methods have been improved and inspection refined until now as little as ⅛ in. of inequality is allowed in 10 ft. of roadway and many concrete pavements are being built which have less than 10 in. of surface imperfections per mile. The better surfaces are being made possible by better finishing tools and the general adoption of heavy steel forms with interlocking ends.



CANTILEVER BEAM TESTING MACHINE
Popular because of its cheapness and portability, useful in permitting earlier opening of road.

Better Measuring—The measurement of batches by weight is an outstanding development. Tests show a decided improvement in uniformity of the concrete and a closer check between the theoretical and actual cement content when the sand and stone for each batch are weighed. When mixers are equipped with more accurate water-measuring devices, the strengths of consecutive batches of concrete should be still more uniform. With the more accurate measurement of materials and the realization that water is second only to cement in importance in the batch, more accurate water-measuring devices are demanded of mixer manufacturers.

Better Curing—The quality of pavements is being much improved by early curing. The result is concrete which is a third stronger than it would be if drying were allowed to begin as soon as the final finishing operation was completed. To an increasing extent concrete pavements are cured by covering them with burlap as soon as the concrete has hardened sufficiently to bear it. This burlap is kept wet by sprinkling until it can be replaced with an earth or straw cover, which is in turn

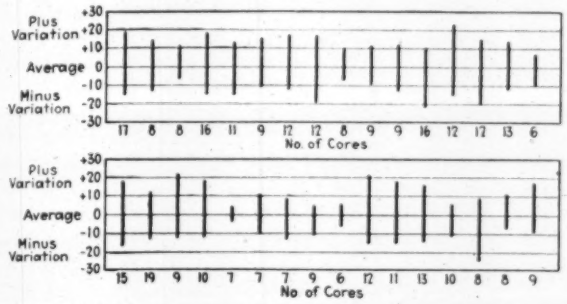


PREMOLDED EXPANSION JOINT FILLER
Being uncovered after it was temporarily covered with concrete so that finishing tools might pass over it.

kept wet until the concrete is nearly strong enough to be opened to traffic.

Better Joints—The temporarily submerged expansion joint and the dummy joint are recent advances in workmanship which are improving the quality of pavements. The expansion material is left ½ in. below the surface of the slab and is capped with a metal channel to hold it rigid. Then the finishing tools pass over the joint unhindered, and because it is somebody's job to remove the concrete over the cap, pull the cap out and edge the joint, it is never left with concrete over it and there is no spalling.

The weakened plane contraction joint in its original form was a deformed metal plate whose top was kept



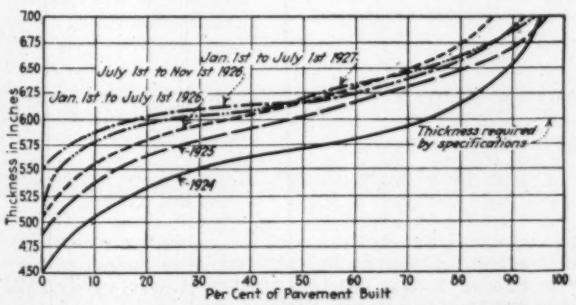
RANGE IN CORE STRENGTHS IN PENNSYLVANIA

Though some investigators report 100 per cent range in core strengths, those from Pennsylvania's pavements usually fall within 20 per cent of the average.

slightly below the surface of the slab. The more recent method of construction, except where a harsh crushed stone is the coarse aggregate, is the formation of a slot about 2½ in. deep in the upper surface of the slab. The slot is made by pushing a long bar like the web of a T-bar into the concrete, either by hand or with a machine which rides on the forms.

Better Verification and Control—The coring of finished pavements is also improving their quality. Cores are drilled at irregular intervals to determine how near the actual depth is to the specified depth. When both inspector and contractor know that a core may be drilled anywhere in the pavement, and especially when the latter knows that he will receive less for pavements which prove too thin, the average thickness is found to be greater. That is shown by coring pavements built before coring was anticipated and comparing their average depth with those of pavements which it was known would be cored. Cores tested in compression usually show a wider variation in strength than cylinders from the same job.

Development of the beam test is also improving the quality of concrete. Beam tests are of service to the



SLAB DEPTHS IN SUCCESSIVE YEARS IN MISSOURI

Greater depth of slab was secured during 1926-27 when contractors and inspectors knew that pavements would be cored than in previous years when coring was not expected.

traveling public because they permit early determination of strength and earlier opening of the pavement to traffic.

Aggregates are more thoroughly investigated in recent years and their suitability for concrete pavements is being more accurately determined. It is also now possible to use aggregate which a few years ago would have been discarded because it did not meet the standard specifications for size. The sand-concrete pavements of Nebraska and Kansas are typical examples. Using the principles developed by Professor Abrams, such material is being used to build very acceptable concrete pavements.

The water-cement ratio theory has been applied to other aggregates with even more satisfactory results. The better specifications require either a certain minimum strength or allow a definite water-cement ratio, the latter with the proviso that if the desired strengths are not secured the engineer may reduce the amount of mixing water and pay for the additional cement which that makes necessary.

* * *

Advances in Gravel Road Construction

By Stanton Walker

Director, Engineering and Research Division, National Sand and Gravel Association, Washington, D. C.

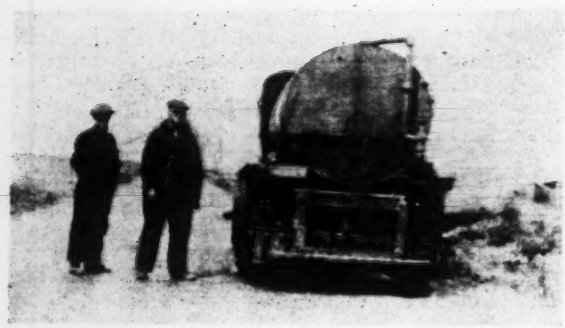
GRAVEL roads which carry hundreds of automobiles per day safely and comfortably at high speeds are a vast improvement over their rough and rutted forerunners constructed to keep horse-drawn traffic out of the mud. Current interest in investigations carried out by the

BROOMING TO REMOVE LOOSE MATERIAL PRIOR TO OILING

Bureau of Public Roads, various state highway departments and the highway research board of the National Research Council looking toward still better construction methods give promise of much greater improvements in the future.

Economic Importance—Observations have shown that properly constructed and carefully maintained gravel roads, without a surface treatment, will give satisfactory and economical service for traffic up to about 600 vehicles per day. Traffic surveys show that a large proportion of our roads, certainly more than 75 per cent, carry less than 600 vehicles daily, consequently justifying the existence and future construction of many miles of gravel roads. Predictions based on a survey carried out in Ohio indicate, for example, that in 1935 not more than one-half of the system of that state will carry a traffic volume heavy enough to require a higher type of pavement than an untreated gravel road.

The addition of a surface treatment to a gravel road



PRESSURE DISTRIBUTOR FOR APPLICATION OF OIL TREATMENT

increases its economical carrying capacity from 100 to 200 per cent for an additional expenditure of only about 10 to 20 per cent of its initial cost. It also eliminates dust, reduces wear in vehicles and improves the appearance and life of the road. Within proper limits of traffic volume, gravel roads may be constructed, surface treated and maintained for periods of five to ten years and sometimes longer at less than half of the initial cost of a "permanent" type of pavement.

An important feature of gravel roads which further adds to their economic importance is that they lend themselves admirably to progressive or stage construction, which implies the improvement of the road with successively higher types of surfaces as required by increasing traffic. Highways can be built in this manner without the destruction or waste of the original investment.

Subgrade—In the preparation of the subgrade the greatest advances have resulted from a better understanding of the action of soils in the presence of moisture and under load. Studies of this question carried out by the Bureau of Public Roads and various state highway departments have shown the possibilities of correcting faulty subgrades by mixing various materials with them.

The intensive studies of subgrade materials which are being carried out with particular attention to improvements in the non-rigid type of pavement will undoubtedly lead to further improvements in gravel road construction.

Quality of Material—Engineers have learned that it is not always economical to use any material which happens to be most conveniently available. The quality of particles, uniformity of grading, maximum size and percentage of fine material and amount and kind of binder are of great importance to the quality of the finished gravel road.

It has been concluded that gravel for gravel-road construction should contain no particles larger than about 1½ in. in the base course and probably not larger than about 1 in. in the surface course. The tendency in future construction seems to be toward the use of even smaller sizes. For binder, materials little affected by the presence or absence of moisture are to be preferred. An excessive amount is an invitation to the formation of "pot holes" under traffic; the use of too little is equally disastrous. Improvements in the future undoubtedly will come with the more general realization of the importance of quality of materials and with greater knowledge of the relationship between the various characteristics of the materials and the local conditions under which they are to be used.

Construction and Maintenance—The compaction of successively applied and relatively thin layers of gravel by traffic, sometimes supplemented by tamping rollers, is now accepted as the surest method of obtaining satisfactory construction. Along with this must go continuous maintenance of the surface to keep it smooth. Developments in equipment, particularly in the application of motor power, have been the most important factors in improving construction and maintenance methods.

Surface Treatment—The greatest improvements and most promise for the future in gravel road construction lie in the treatment of the surface. An untreated gravel road requires excessive labor to maintain a smooth surface after the volume of traffic exceeds 500 to 600 vehicles daily. Replacement of material blown and washed away becomes expensive and rapidly depletes the supply of gravel available for the road. The dust nuisance, which comes with excessive traffic, is also an important factor which must be taken into consideration.

Light oils and calcium chloride spread over and mixed with the surface of the gravel road have proved effective in eliminating dust. They have also greatly reduced the amount of material lost from the road surface. Heavy oils, tars, cut-back asphalts, etc., mixed with fine gravel, have been extremely valuable in conserving the road metal, eliminating dust and greatly reducing the wear on vehicles.

The ability of the gravel road to carry light traffic economically and the need that still exists for providing some kind of a surface for something more than 2,000,000 miles of roads insure further attention to gravel-road construction methods and consequent improvements in them.

* * *

Crushed Stone Roads

By A. T. Goldbeck

Director, Bureau of Engineering, National Crushed Stone Association, Washington, D. C.

NEW types of stone road construction have been developed, and further improvement is well in sight. The old macadam road structure and construction no longer sum up the ability of the stone road to give, within wide traffic limits, smooth, clean and enduring service.

BITUMINOUS MACADAM STEPPED CONSTRUCTION

Present programs and future possibilities as they present themselves may be summarized very briefly as follows:

Waterbound Macadam—In the construction of waterbound macadam roads mechanical devices have been developed for spreading the stone evenly and uniformly over the subgrade without re-handling, as was formerly the practice. There has been an improvement in design in three possible respects:

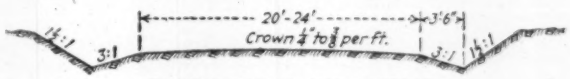
1. The use of more adequate thickness for heavy wheel loads; total thickness of 8 to 12 in. are not unusual.

2. The use of larger sizes of crushed stone in the base course, especially when the stone is comparatively soft. Stone of medium softness passing a 4½-in. ring and in some instances a 6-in. ring has been used very successfully in the base course in the Middle West.

3. The use of blanket course of granular material when the subgrade is soft to prevent its upward intrusion into the stone during rolling and later.

Although waterbound macadam is not suited for high-speed, intense traffic, it is still widely used for the lesser highways and for much temporary construction. Here it still serves an economic need as a base for other surfaces. Attempts to increase its load-carrying capacity are worth while. These should take the form of strengthening the edges either by stepped construction, by thickening, or both, or by the use of granular treatments of the subgrade to improve its load-supporting value. Also much remains to be learned as to the stability of stone depending upon its size.

Surface-Treated Macadam—Fast-moving automobiles



TRAFFIC-BOUND STONE ROAD

require that a macadam surface be bound, generally by a bituminous binder. One of the greatest advances in surface-treated roads has been in the use of a long-base drag after the small-size crushed stone covering material has been applied. Surface-treated macadam may be improved by the development of still more permanent bituminous materials and by a better technique in their use with the proper size and quality of cover material.

Retread Surfaces—An outstanding development in the stone road is the so-called retread surface, and closely allied to it is the oil-macadam surface. The retread surface is intermediate in value between surface-treated macadam and bituminous macadam or bituminous concrete.

Bituminous Macadam—The foundation for bituminous macadam has been improved recently by the extension of the base course at least 6 in. on each side beyond the surface course and similarly the extension of the foundation course beyond the base course, thus resulting in so-called stepped construction. The steps more widely distribute wheel load pressures to the subgrade and the road is thus better enabled to carry heavy loads at the sides than when surface, base and foundation courses are all of the same width.

An advance in construction technique is the use of a strike board and longitudinal templet for insuring the proper degree of smoothness in the base and also in the surface course. Specifications should require no greater than ⅜ in. depression in 18 ft. when tested by a templet.

The bituminous macadam road requires the most careful attention to every detail of construction. Uniformity everywhere, in every operation, is the keynote of success. The hope of immediate improvement in this type lies in better inspection.

Bituminous Concrete—Improved methods of laying, particularly in the use of a mechanical screed, are under development, and the greatest possibility of progress seems to lie in the development of laboratory means for determining the most stable mixtures for various climatic and traffic conditions. Developments in bituminous concrete are exemplified by the several cold mixes employing cut-back bituminous material and most recently by a mixture partly premixed, shipped in granular form to the job, reheated and mixed in an ordinary concrete mixer before laying.

Traffic-Bound Stone Roads—An outstanding recent development in the use of stone is the traffic-bound road. The method consists first in the preparation of a proper cross-section to receive the stone. That illustrated gives good results, and care should be taken with grade and alignment, for this road will attract traffic and later may become a primary road.

The traffic-bound road is not suitable for heavy traffic. It is economical up to 600 vehicles per day, and above that number should be surface treated or given a better surface. It is an excellent road for the rapid development of a highway system and forms a good foundation for all higher types because all of the weak spots are disclosed by traffic and are repaired by the maintenance methods used. It is a form of stage construction.

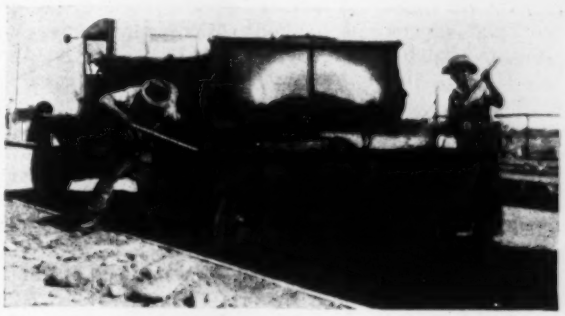
* * *

Bituminous Roads and Pavements

By Prevost Hubbard

Chemical Engineer, Asphalt Association, New York, N. Y.

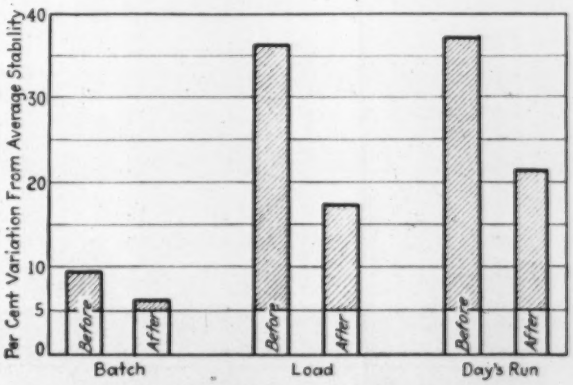
WITH the recent development and growing use of the stability test and other physical tests of a similar nature applied to compressed asphalt paving mixtures, the various factors governing design are now being analyzed in a logical and scientific manner. By the use of such tests it has already been demonstrated that marked improvement in uniformity of plant output may be se-



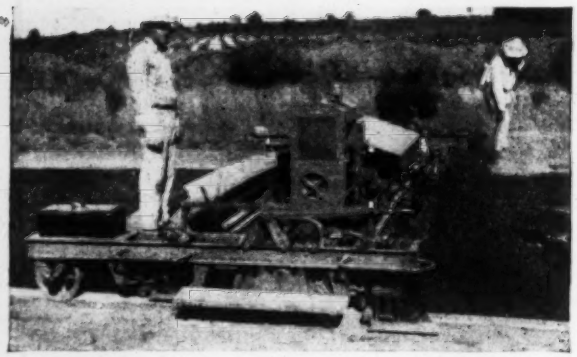
MACHINE FINISHING ASPHALT PAVEMENT

cured by detecting and eliminating the various causes of lack of uniformity. More accurate control of uniformity of plant output may therefore be considered as an immediate accomplishment in developing true perfection of quality in the pavement itself.

Independent paving plant studies conducted during the past year by the U. S. Bureau of Public Roads and the Asphalt Association have indicated the desirability of improvement and standardization of certain details of plant equipment and operation which, when generally adopted, will undoubtedly be of material assistance in



VALUE OF STABILITY TEST FOR CONTROLLING UNIFORMITY OF PLANT PRODUCT



MODERN METHOD OF SPREADING BITUMINOUS MIXTURES

securing better pavements. Among these may be mentioned:

1. The proportioning of both asphalt and mineral filler upon a weight basis for each batch.

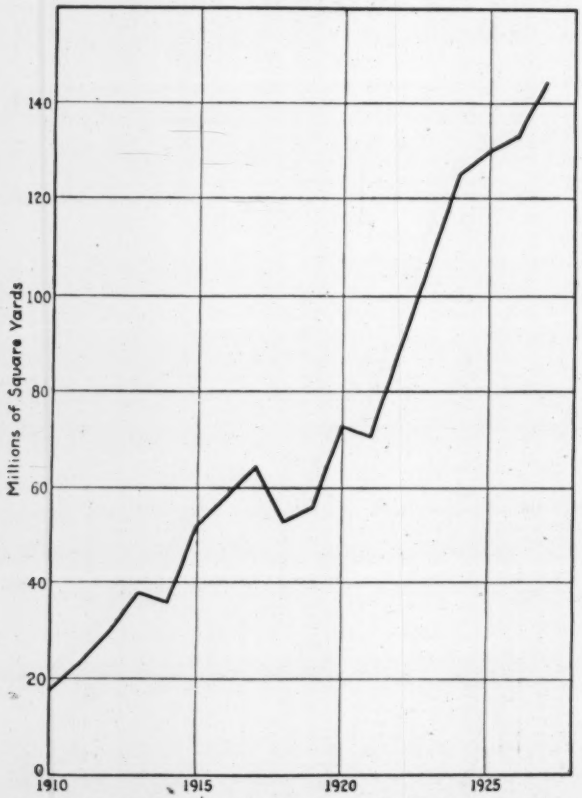
2. The design of more efficient mixing apparatus with especial reference to arrangement and spacing of mixing blades.

3. The adoption of definite periods of mixing, particularly the period of dry mixing, based upon the most efficient and economical method of obtaining uniformity within the batch for a given mixture.

4. Use of timing devices to control the period of mixing.

5. For large jobs, the predetermination and use of modified formulas to care for normal and expected variations in mineral aggregate as determined by the usual methods of plant inspection.

An inherently stable and dense mixture may produce a very unstable wearing course if it is not thoroughly compressed during construction. The best and most efficient method of compaction still remains to be ascertained, but the use of a heavy three-wheel roller for initial compression is finding increasing favor. Thorough compaction may be more readily obtained by tamping than by rolling or direct compression, and it would seem that the development and use of a mechanical tamping device to be operated on wearing surfaces directly ahead of the roller might logically be expected as a future improvement in this detail of construction.



ANNUAL YARDAGE OF ASPHALT PAVEMENT LAID YEARLY 1910-27

Smoothness or riding quality of an asphalt pavement should be built into it. Perhaps the most promising single advance that has been made in this connection is the practical adaptation of the concrete finishing machine to the laying of asphalt pavements. When the surfaces of mixtures so laid are carefully straight-edged during rolling, a degree of smoothness closely approaching the ideal may be obtained.

With reference to the bituminous macadam the factors controlling quality of the finished pavement are:

1. Use of a uniform size broken stone product in the main body of the wearing course so as to secure a uniform distribution of void spaces sufficiently large to permit uniform penetration of the bituminous binder.

2. Uniform application of the bituminous binder in correct amount and under conditions favorable to uniform penetration.

3. Thorough interlocking of the broken stone by rolling during construction and back rolling after construction.

4. Construction of a foundation with adequate supporting power for the weight of traffic which the pavement may be expected to receive.

Any summary of progress would be incomplete without some mention of bituminous surface treatments. Such a variety of methods and results have been developed in recent work as to emphasize the necessity for continued intensive study of low-cost road construction by such means. Stage construction from the subgrade up through surface treatment to the highest types of bituminous pavements promises to be one of the most important developments in our future highway program and treatment of the vast mileage of secondary roads such as earth, sand clay, top soil, gravel and broken stone with bituminous materials appears to be the most important step in such evolution.

* * *

Brick Pavement Construction

By George F. Schlesinger

Chief Engineer and Managing Director, National Paving Brick Manufacturers Association, Washington, D. C.

BRICK is perhaps the oldest used paving material—at least its pavement history goes back to Babylon and Nebuchadnezzar. Brick roads built by Napoleon are in service today. And in the United States there are many brick streets paved 30 to 40 years ago. All this is by the way of pointing out that in the requirement of durability brick offers all that future traffic can ask. It also has another element of life peculiar to itself; it can after use has roughened one surface be taken up and turned to present a fresh, smooth surface to the attack of traffic.

A brick pavement is essentially one not made in the field. The component units are manufactured under plant control and are not subject to weather and other uncer-

tainties. Today the only specification necessary for vitrified paving bricks is the rattler wear test standardized in 1911 by agreement between the engineers and the manufacturers. By this comparatively simple means the paving engineer is assured of a product of tried and uniform quality.

Brick sizes are standardized. Five sizes of paving brick, with perhaps another size to be added, serve all paving purposes. Six years ago there were more than 60 sizes; the simplification has been brought about by a committee of engineers and manufacturers working under the auspices of the U. S. Department of Commerce. The change is a far step in adapting brick pavements to future roadbuilding demands.

Advances in construction are thinner cushions and bituminous joint filler. The present-day brick pavement is designed with a much thinner cushion course than formerly. This is possible because modern specifications require the base course to be finished practically as smooth as the surface of a road. The cushion should not be thicker than 1 in. and preferably $\frac{3}{4}$ in.

The filler now advocated is a bituminous or flexible material. Practically all of the filler used in modern brick pavements is asphalt. In a few instances tar pitch mastic is still used, and the tar interests are now working on the development of a tar filler containing an admixture that will make it suitable for use in brick pavements. Some experimentation is being carried on to determine the best consistency of asphalt to use as filler. In addition to the joints being sealed against the entrance of moisture, the difficulties incident to temperature changes, such as occasional blow-ups, have been obviated by the use of a soft filler.

The outstanding development is the practice common in the last few years of taking up old brick in pavements 30 or more years old and relaying them in new improvements. It has in some cases been possible to avoid entirely the purchase of new brick. Many relaying projects of this kind have been constructed. They have the appearance of new pavements and are striking illustrations of the long life and salvage value of vitrified brick as a paving material.

Vitrified brick has also found favor as a resurfacing course for old pavements that have begun to fail and break up under traffic. Many of these were built 14 and 16 ft. in width and by widening with a curb on each side and covering the existing pavement with an asphalt-filled brick surface course on sand cushion, the old paving can be salvaged and the result is a very fine appearance and substantial road or street. The cracks in the old pavements will not appear in the brick surface, because of its being composed of small units separated by bituminous joints each of which acts as an elastic medium. At the same time the pavement has, to a considerable degree, the attributes of a rigid surface.

The sixteen-year Chevy Chase-Connecticut Ave. road test conducted by the U. S. Bureau of Public Roads has shown conclusively the economic advantage of the two-course type of pavement design. The modern vitrified brick pavement composed of tough, dense units resistant to the destructive agencies of climate and traffic, the interstices between the vitrified bricks filled with an elastic and adhesive bituminous seal, laid on a thin cushion course which in turn rests on a foundation suited to local climatic, sub-soil and load conditions, satisfies the requirements of an economical, pleasing and high-quality two-course pavement. It has survived the changing conditions of the last half-century. It will continue to play a prominent part in future highway transportation development.

MODERN METHOD OF FILLING JOINTS IN BRICK PAVEMENT

Line Sidewalks to Effect Pedestrian Control

TO AMELIORATE congestion and promote safety a voluntary method of pedestrian control was put into effect in Detroit during the holiday season. Sidewalks as well as crosswalks at intersections were marked off in lanes with large footprints denoting the intended direction of pedestrian traffic flow. On the sidewalks two fluid traffic lanes were provided and a third lane alongside the buildings was designated window-shoppers' lane. To insure the observance of the system so marked, police were stationed at certain points, cartoons were sent to the schools for exhibition and signs on standards were placed on the walks.

Appropriate signs urged the walkers to cross with the traffic, but this was not compulsory, for Detroit has no ordinance on pedestrian control. H. M. Gould, newly appointed traffic engineer, states that it was hoped to substitute common sense for compulsion in getting the pedestrian to turn square corners, keep to the right in his own lane and cross streets with the traffic. The sidewalk markings were placed on each side of Woodward Ave. for two blocks from city hall to State St. The crosswalks were marked from city hall to Grand Circus Park.

One intersection is to be equipped with an automatic device that, in connection with the green signal aspect, will indicate how much time is available during the display of the green signal for pedestrians to start across, taking into account the total time required. Signals at crossings of Woodward, a 120-ft. street, change at 30-second intervals. Mr. Gould has found that the average man crosses in seventeen seconds, but the average woman takes nineteen seconds to make the same journey.

As a further aid to better efficiency in sidewalk use, mail boxes, waste containers and news stands were removed from the street corners during the holidays.

Highways Lead to Higher Values
Of Farm Land and Products

Good Roads Increase Market Radius of High-Value Produce, Diversification Is Encouraged, Living Standards Raised and Better Population Attracted

By George R. Chatburn
Lecturer on Highway Engineering, University of Nebraska, Lincoln, Neb.

TWO of the principal factors of farm land values are productivity and market facility, for without either the land for farming purposes would be practically worthless. Dependable markets and easy marketing facilities inspire greater production; greater production is conducive to a denser population. The land value is a summing up of all factors involved into a money measurement of the economic relation of supply and demand.

A NEBRASKA FARMSTEAD OF THE PRESENT
Many of these farmsteads appear like small villages and have almost as up-to-date conveniences.

Farming Zones Widened

With all things equal except distance to market, there would evolve about each market center a series of zones made up of different types of farming. Nearest the market would develop a system of intensive farming largely of perishable products, which, to fill the demand for well-conditioned produce, must be marketed daily. Beyond this first zone would come other and larger zones, where it would be more profitable to raise the less perishable crops, those which may be harvested and marketed at longer intervals. And so on to the non-perishable crops, those which can be harvested and retained on the farm indefinitely and marketed whenever convenient or when prices are at their highest. Finally there would be the broad zone where it would pay best to graze cattle, horses and sheep. In reality, owing to varying conditions, the zones are more or less interwoven.

The inner-zone intensive farming, such as truck and berry gardening, requires the greatest amount of labor per acre. It will therefore support the densest population and is in greatest need of good roads. With ordinary earth roads and horse-drawn vehicles, 10 miles was practically the limit for this type of farming. With paved roads and trucks, 75 miles may not be too large a radius. Marketing points over the country are so situated, however, that the average haul will probably not exceed 30 miles. Around large cities the limit of this zone is extended by the large demand; contiguous territory may not be sufficient to supply it, and then the railway is utilized to transport the products. In such cases, however, the market point is really the near-by railway station and not the ultimate destination of the produce.

As these zones are extended by better roads, the larger, less intensively cultivated farms are divided into smaller tracts. The area that formerly sustained one family now sustains two, three or four families. So, as the zones are widened, the density of population is increased and its distribution will become more uniform.

Diversification Encouraged

The use of the truck on surfaced roads not only has widened the farming zones but has reduced the unit cost of hauling. Where large loads are available and large trucks can be used, the reduction is, for an economic length of haul, considerable. "Truck Facts," published by the Automobile Chamber of Commerce, 1927, states that "analyses of available operating cost records of commercial haulers indicate that the short haul, 45 miles or less, is profitable, while the long haul is generally un-

profitable." The surveys indicate that the average actual haul is even smaller than this, ranging from 23 to 32 miles. What is true of commercial hauling would probably be true of farm hauling where there is a sufficient amount of the latter for daily marketing. Farm co-operation would assist in securing that amount; it has been found to be profitable for one truck to collect milk from several farms.

Emulation is a great influencing agent. If one farmer can receive $50 to $75 a month for a few cans of milk or cream per day, the neighboring farmer longs to do likewise. As a final result many farmers go into dairying in connection with other farm work, the farmer benefiting by ready money, the farm by refertilization and the community at large by a general circulation of funds.

The grain farmer usually adds to his farming more or less stock raising. He frequently finds it more profitable to market his grain through hogs and cattle than directly to the elevator. Nowadays most of these animals are marketed alive. They are usually hauled to the railway station, where a dealer purchases them and as soon as he has a carload lot ships them to the packing center. With horse-drawn vehicles and dirt roads a 12-mile haul was about all that was practical, and even that was sometimes disastrous in hot weather. With the truck and surfaced roads that distance is easily accomplished.

In appraising the value of highway improvements, service to the farm is a large factor. The ultimate gage of farm service is land value. This is the measurable sum of all the tangible and intangible gains that the good road brings to the agriculturist. It is common belief and assertion that road service increases land values on the farm. In what way and how much and, particularly, how may we figure the amount? Dr. Chatburn undertakes to answer in brief terms this tripartite question. In doing so he draws upon the studies conducted in the preparation of his notable volume on highway transportation and his intimate knowledge of road and farming conditions in a distinctively agricultural state.

In the zones of general farming the introduction of good roads, truck hauling and labor-saving machine farming attracts people having high standards of living that can be satisfied only by the production of more commodities or by higher prices for those produced.

An official of the Bureau of Agricultural Economics of the U. S. Department of Agriculture has recently stated that farm returns depend upon world supply and demand and not on the cost of production in the farm belt of America. If this be true, then the only way in which a standard of living can be maintained on the farms equal to that in the cities and villages is by increasing the size of farms, reducing the labor by machinery and making marketing less expensive by good roads. Census reports show that the percentage of farm population compared with urban population is decreasing, and in many farming districts the actual number of persons occupied in farming per acre is lessening. Several years ago the most profitable farm was considered to be the 240-acre, two-man, six-horse tract, whereas now the most profitable farm is considered to be the 320-acre, two-man, twelve-horse or one-tractor and four-horse tract. This shows a decrease in man power and of course greatly diminishes the density of population in the districts devoted to general farming.

Land Values Increased

The last proposition to be considered here—namely, the effect of road efficiency upon land values—is one that calls for additional research. Data are to be had in the appraisal values of lands kept by loan agencies, the assessed values at county seats and the sales values usually recorded in the offices of registers of deeds. The collation and analysis of these data would be an enormous and expensive task. The difficulties of analysis would be greatly enhanced because the recorded items would not give the investigator any idea whatsoever of many factors that enter into the money value. It would therefore be necessary for him to inspect personally each farm tract.

P. L. Gaddis, chief appraiser, Lincoln Joint Stock Land Bank, Lincoln, Neb., states in "Annals of Real Estate Practice," Vol. V, 1927, published by the National Association of Real Estate Boards, Chicago, that the two most important factors in farm values are climate and soil. Upon both of these depends productivity, which of course is the ultimate end of a farm considered as a factory and not as a home. "Land of approximately the same quality cannot be valued the same under a rainfall of 21 in. as it can under a precipitation of 30 in." The length of the growing season likewise affects value. The second big factor, soil, must be studied for its quality, depth, texture, slope ("lay of the land") and mineral constituents such as lime, alkali and acidity. Other factors such as humus and nitrogen, moisture, drainage, leaching and special taxes (actual or prospective) are also important factors. There are also other factors, economic and social, such as the farm's location in reference to cities, markets and roads; the character of the surrounding population; the size of the farm, and its improvements and income.

All this shows the difficulty of selecting one factor and determining its relation to road efficiency. However, Mr. Gaddis gives considerable weight to roads and classifies the farms as located on:

1. A surfaced road—pavement or gravel.
2. A primary or marked highway of earth that is well graded and well maintained.
3. A graded road that is not a thorough highway but is fairly well kept up.
4. A road with some travel but worked only enough to make it passable.
5. A fairly good private road or at the end of a public road.
6. No road at all, but only a trail.

Mr. Gaddis suggests that in order not to overemphasize roads the land should be first appraised as though situated under road conditions described in No. 3, then add a certain percentage—say 10—if it has road conditions No. 2, or subtract 10 per cent if it has road conditions No. 4.

Land Value Formulas

A few actual investigations have been made to ascertain the relation between land values and the factors entering into them. These, however, are more or less sporadic and do not cover a sufficient number of cases.

In 1922 Guy W. Walrod, a graduate student in civil engineering, wrote a thesis (this is unpublished, but is in the library of the University of Nebraska) on the "Economic Values of Nebraska Highways," wherein he attempted to get a money relation between the highways and certain farm values, using data that had been collected by the department of rural economics of the University of Nebraska for another purpose. They cov-

ered 124 different farms of varying sizes in Cass County, Nebraska.

Mr. Walrod first plotted distances from the state highway as abscissas and the number of acres in the farms as ordinates and drew a balancing curve through the plotted points. He gives the equation of this curve to be $y = 160 - 10x + 6x^2$, a parabola showing a marked increase in size of farms with distance from the highway. Little if any relation was found between the number of rooms in the farm residences and distance from highway. Land and improvement values per acre (selling price of ground, fences, trees, drainage, but not the building or the farm equipment) gives him the curve $y = 250 + 3\ (4 + x)^2$, where y is the land and improvements value per acre and x the miles distant from a state highway.

According to this curve land values decrease as their distance from the highway increases up to 4 miles, but afterward increase, due, according to Mr. Walrod, to other roads than state highways at a nearer distance and to proximity to villages and towns. He thinks it evidence that the influence of the state highway extends at least 4 miles, and so on for other elements. Finally Mr. Walrod gives the equation, $y = 300 + 3\ (4 - x)^2$, which shows for the lands considered a decrease in values, up to a distance out of 4 miles, of about $12.40 per acre per mile, or 4 per cent of land value.

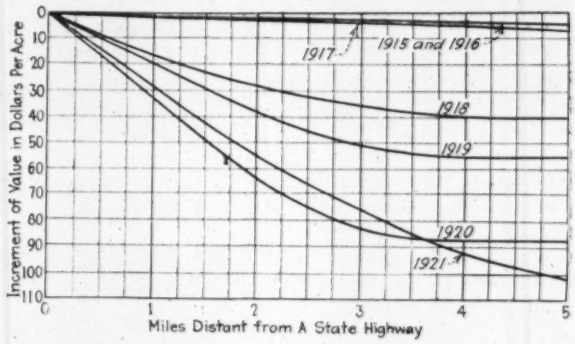
Mr. Walrod, not quite satisfied with this investigation, determined to study the sales values of lands in York County, Nebraska. In this he took the transfers from the county offices for the years 1915 to 1921. The county had two state highways through it meeting at

A NEBRASKA SOD HOUSE OF THE EIGHTIES
During the Eighties land in the Western plains region was worth little; most of the houses, stables, and stockage fences were made of prairie sod.

right angles at the county seat near the center. Mr. Walrod plots 27 curves to show the results of his work. A modification of one of his plots is given herewith to show his idea of the relation between land value and distance from the highway. It shows increments of land values as the farm approached the state highway. While he has given results in dollars, from his figures may be calculated percentage increases in the prices of land as related to distance from highway. Thus, using the value of land 5 miles from the highway as basis, that adjoining the highway had a percentage increase in: 1915, 7; 1916, 9; 1918, 28; 1919, 26; 1920, 46; 1921, 72.

It is well to note that these years are rather unusual, for at this time occurred the World War with its early depressing effect and later inflation.

One of the most technical and scientific investigations of the influence of nearness to market and efficiency of roads on land values is that of G. C. Haas, of the division of agricultural economics of the University of Minnesota ("Sales Prices as a Basis for Farm Land Appraisal," Technical Bulletin 9, University of Minnesota, Agricultural Experiment Station, 1922). Mr. Haas selected 160 farms in Blue Earth County, Minnesota, which had actually been sold during the four-year period 1916 to 1919. The method of analysis was an application of the principles of the mathematical theory of statistics, using Pearson's coefficient of correlation.



INCREMENT OF LAND VALUES DUE TO HIGHWAYS

He considered five factors as entering into land values: X_1 = value per acre; X_2 = 1919 depreciated cost of buildings; X_3 = land classification (meadow, till, woods, etc.); X_4 = productivity of soil index; X_5 = distance to market.

These lead to very complicated and technical equations. To get consistent results, certain corrections were necessary. Indices for these were worked out. Sales values for the several years, reductions for the character of the land, etc., had to be brought to a comparable basis. Among other things a differential for state macadam and dirt roads was sought. In the final results lands on macadam roads were reduced to a dirt-road basis. First of all, a tabulation gave the following results:

Average value per acre of 10,393 acres on dirt roads	$147
Average value per acre of 4,873 acres on state roads	171
Differential	$24

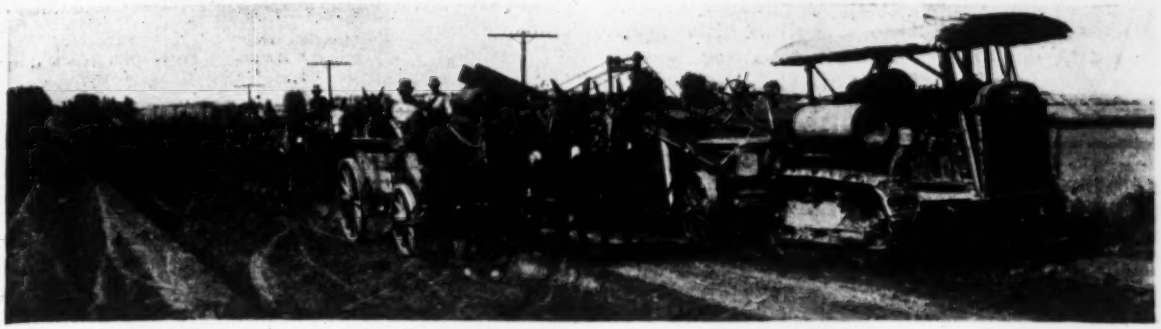
Finally a weighted average differential of $21.92 was obtained. This was tested and checked in various ways.

Space will not permit extensive mention of other factors, but it will be interesting to note the differential obtained for "influence of cities and villages." A study of the different towns and villages was necessary to reduce all Class I towns to a Class II basis, the differential being $12.82 per acre.

After studying, combining, eliminating and modifying the many things that might influence, the factors above mentioned were considered in multiple correlation. The forecasting equation which resulted is:

$$X_1 = 57.785 + 1.067X_2 + 0.7279X_3 + 0.1658X_4 - 3.422X_5$$

Mr. Haas states that the "most interesting and yet the most difficult relationship to study was that of distance to market and value per acre. Coupled with this relationship is the relative significance of the type of road and class of town. "On a farm which is on a dirt road and adjoining a Class II town, each mile from town decreases the land value per acre $3.42." In another place he states that "other things being the same, the farm farthest from market, 11½ miles, is worth $35.92 less per acre than the farm a mile from market." While the sales value of this farm is not given, the depreciation must be approximately 25 per cent of its value.



Tractor, Elevating Grader and Team Grading Outfit

Meeting Volume Requirements Through Increased Efficiency of Road Construction

Development in Plant and Methods Makes Roadbuilding Possible on a Much Larger Scale at No Increase Over Present Prices and With Fair Chances of a Decrease

By C. M. Hathaway

Engineer of Construction, Illinois State Division of Highways, Springfield, Ill.

A STEADILY increasing highway program is rapidly providing a system of trunk highways. Now the increase in motor car and truck production presents another problem of grave importance. There is today a necessity for wider traffic lanes, the elimination of the bottlenecks, adequate terminal facilities, separation of grades, provision for handling high-speed through traffic around the larger population centers, and the separation of this through traffic from the slow-moving local travel.

This condition presents, first, a financial problem, and second, the development of a suitable design. And finally, with these two problems solved, there enters another important factor, the facilities for handling the construction of these highways as rapidly as needed.

Are the materials available to meet the demand for a larger program? Can the railroads handle this increased freight tonnage within a limited construction season? Are there enough reliable contractors available to finance and operate an adequate construction organization? Have the equipment manufacturers developed sufficient up-to-date machinery to supply the increasing demand? Has there been developed an engineering organization capable of administering and directing the construction of this system of roads with efficiency and economy?

A study of the development of this feature of highway work in the State of Illinois during the past fifteen years leads me to state definitely that all of these essential units can meet the demands, and their development has made it possible to build roads on a large scale.

As an example I cite the year now closing. During 1928 there was completed by the Illinois State Division of Highways 1,300 miles of 18- and 20-ft. pavement. Heavy grading and bridge work were of similar magnitude. Throughout the season it has been particularly noticeable that there was seldom a day lost due to lack of materials or shortage of cement, and from a chart shown elsewhere in this article it will be noted that there was a 20 per cent increase in daily run over any previous year. Furthermore, there was no lack of contractors, as is shown by bids received at lettings which were held during the year and at a time when 75 per cent of this program was already under contract.

A careful study of this subject leads me to state also that, on account of the increased efficiency in all phases of road construction, this program can be handled at no increase in prices and generally at a decrease when compared with the present value of the dollar. In addition, with standard equipment and efficient construction operation, the present-day pavements carry a guarantee of full thickness and of a definite quality and strength.

As the pavement construction in Illinois has been mainly of portland cement concrete, it will be necessary in this analysis for me to draw my conclusions on this basis, but the constuction methods of other types are so nearly in the same category that it is safe to state that the same general facts are true when applied to them. Illinois experience is therefore presented in what follows as indicative of general experience.

Materials

The geological formations of Illinois are such that there are few local deposits worth opening up for an individual job; it has been necessary to develop commercial stone quarries, gravel and sand pits. The freight haul usually exceeds 50 miles. This enables the bureau of materials to list all the available sources of supply in and adjacent to Illinois and to know the capacity of each plant. A comparison of the past ten years shows a definite increase in production. This has been accomplished in part by opening up new pits and quarries, but chiefly by increasing daily production, by the installation of more economical and efficient equipment and by 24-hour operation when required.

Probably the most conclusive evidence of the ability and intention of the material companies to meet the de-

mand is that from 1919 to 1923 it was necessary for the contractor to store from 33 to 50 per cent of his aggregates (partly due to railroad facilities) during the early months of the year, in order to have a storage pile from which to draw during seasonable working months. In the years 1926, 1927 and 1928 storage was reduced, and there were many instances where the contractor was able to anticipate daily shipments regularly enough to handle his construction requirements with very little stockpiling. A 1,300-mile program just completed has definitely demonstrated the availability of an adequate supply of aggregates. Furthermore, I have noted a normal program in adjoining states and no lack of aggregates for municipal paving and building projects.

Table I shows the amount of cement bid, in comparison with the actual requirements. From 1920 to 1923 the construction program was actually curtailed due to the inability of the cement companies to supply and the railroad companies to haul enough cement. From 1926 to 1928 the companies offered four times the actual requirements. In 1923 it was necessary to store 1,200,000 bbl. of cement during the first three months of the year and 1,650,000 bbl. was stored in 1924. Cement companies in making their bids specified that they could not handle the construction program otherwise. Since that date the necessity for large storage has not been stressed, and in 1928 it was common practice for the railroads to take a shipment of cars from the mill one day and deliver them to the job the next morning, even though it may have involved a haul of more than 100 miles and oftentimes may have necessitated interchange between railroads.

When a greater road improvement program has been planned and financed, can the work be done fast and cheaply? Are there enough trained contractors and engineers; can materials producers supply the larger volumes of cement, sand, stone, brick and asphalt and can the railways move and deliver them promptly; have we the large capacity equipment and quantity-production processes for more and faster road construction? Mr. Hathaway, from his experience in one of the most active high-class roadbuilding states, answers these questions in the affirmative. And he gives the facts and reasoning on which his answers are based. The article is an unusual appraisal of the constructor's ability to produce roads in quantity, at low cost and of superior quality.

Early cement shipments to Illinois road projects were confined to local mills or those within 100 miles of the border. In 1928 mills in Kansas, Ohio, Kentucky and Michigan shipped 25 per cent of the cement used. Evidently the cement manufacturers have planned ahead on the development of a comprehensive nation-wide roadbuilding program.

Table I—Ratio of Cement Bid to Cement Contracted For

Year	Per Cent	Year	Per Cent
1922	100	1926	418
1923	100	1927	470
1924	106	1928	348
1925	145		

In 1928 the requirements were 40 per cent greater than those of 1927. The percentage shown is a ratio of the amount of cement offered at the time bids were received against the amount of cement contracted for to meet the year's requirements.

Railroads

Rail facilities also have developed to handle the roadbuilding program. The average railroad has come to realize that the highway is a necessity and not a competing traffic agent. It also realizes the possible source of revenue in handling roadbuilding materials, and to accommodate this new commodity it has developed a service which is truly remarkable. During the period from 1919 to 1924 it was always necessary to provide storage facilities to tide over the period during August, September and October, when the railroads were overtaxed on account of coal and grain movements. Customary warnings were filed during July and August cautioning highway officials of the probability of a shortage during the later months and during that period shipments were always curtailed at a considerable loss to contractors.

Table II—Size of Mixers in Use on Pavement Construction

Year	Percentage Under Five-Sack Batch	Percentage Five- to Six-Sack Batch
1921	83	17
1922	23	77
1923	24	76
1924	15	85
1925	10	90
1928	None	100

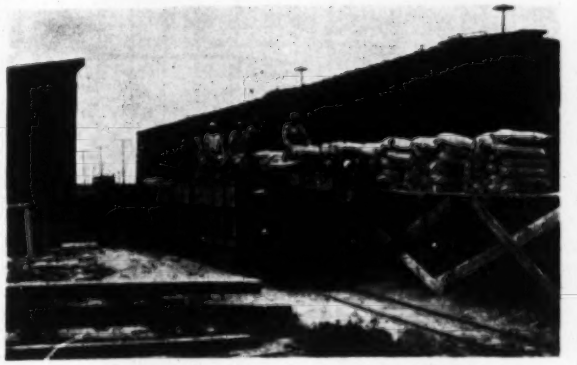
In 1928 it was not necessary to store more than 1,000 bbl. of cement on any paving job, and in many instances no storage at all was maintained. The same was true of aggregates. One of the best indications of this idea of service is the fact that, at each letting, representatives of the railroad companies are always in attendance to solicit business from the low bidders. There is now real consideration and competition for this business as reflected by the records of the Interstate Commerce Commission in applications for rate adjustments.

I have made several references to storage of aggregates and cement and to car shortage during the period from 1920 to 1923. Whether the railroads curtailed the cement and aggregates shipments, or whether the commodities themselves were not available, might be a question, but the fact remains that all three interests have combined to give adequate service without the necessity for large storage. Under such conditions I am satisfied that the construction program can be increased appreciably without fear of a lack of materials or a car shortage.

Equipment

If space provided, I might make a detailed analysis of equipment and construction methods during the period 1919 to 1928, item by item, as compared with present practice. This would indicate that equipment is keeping pace with construction. It would also show how the uncertain element hand labor is being supplanted by efficient machinery wherever possible. Such an analysis would include such features as hand preparation of subgrade as contrasted with the present mechanical subgrader; the old hand method of setting forms as compared with the present form grader, which cuts out to a solid foundation and exactly to line and grade; the old wood or steel form of uncertain stability as compared with the present forms which are designed for a certain bearing on the subgrade and a certain loading imposed by the mechanical finisher, and a comparison of the delivery of materials on the subgrade to be hauled to the skip in wheelbarrows with the present direct delivery by trucks or industrial railroad.

Also compare the different types and sizes of mixers in use from 1919 to 1922 with the present mixer of



MODERN CEMENT BATCHING PLANT

standard design and size, which has been developed by agreement of the manufacturers and which has been approved by the Associated General Contractors. Table II shows interesting figures on this subject.

Equipment is no longer in the experimental stage. The machinery designers have spent much time in a study of plant layout and production methods with the idea of standardizing equipment. It is an established fact that much new machinery developed during the past ten years has been discarded or redesigned at the manufacturers' own expense because it showed its economic uselessness under actual working conditions. It is markedly noticeable that manufacturers and jobbers are now co-operating so that instead of each manufacturer promoting his own sales, equipment is being furnished through supply houses handling several products—that is, the complete equipment for the average paving job. Generally the jobber is prepared to outfit completely any contractor.

Equipment manufacturers have been working for years directly with the officials of the highway department and contractors. At the present time a satisfactory paving outfit is a well-balanced plant in which each unit is designed to operate with maximum efficiency with the other units, and efforts are now more or less directed to improvements in the units from the standpoint of economic plant operation rather than in the development of new wildcat equipment. With such a situation existing, are we not safe in assuming that there will be sufficient equipment to handle an increased program of pavement construction?

Contractors

I see no reason to fear a scarcity of reliable contractors. In May bids were asked on 24 sections and there was an average of 4½ bids per section; at a letting in June 25 paving sections were offered with an average of seven bids per section; and in July 22 paving sections were offered with an average of 6½ bids per section. It must be remembered that on June 1 there was already under contract 975 miles of paving and that the work offered at these three lettings carried a provision that it be completed during the 1928 construction season.

During the creative period from 1919 to 1924 contractors were confronted with a maze of new construction methods and untried machinery, a lack of proper organization and inefficiency of labor and the fact that the highway engineer had very little to add of a constructive nature. Today the average contractor knows exactly what he is bidding on; he has examined the job and has figured the earth-moving machinery, the material supply, the plant layout and the type of hauling equipment best suited. He may even refuse to bid on a job because it is not adapted to his outfit. He has an organization composed principally of full-time men who have been working for years on pavement construction. He has learned the value of studying such points as water supply, average haul, ruling grades, material sources, railroad facilities, switching service and plant arrangement. Keen competition has made him learn the necessity of considering every factor where a cent or two per square yard may result in his winning or losing a job and likewise where a cent or two overlooked may result in a profitable job being turned into direct loss.

The accompanying graph shows the development in daily output of concrete pavement during the past eight years. This is the best evidence of what has been done and of what we may safely estimate for the future.

The curve shows a rapid increase up to 1924, when production became more stable, and during 1926 and 1927 there was very little increase in daily production. This is exactly what might be expected when we remember that the contractors were developed along more rational lines during that period and were organized for maximum efficiency. The year 1928 does show a marked increase, which is manifestly natural when we appreciate that the program was nearly double that of each of the three preceding years. Naturally the sections awarded to a single contractor were longer and there was every facility and incentive for him to make better progress.

A single paving outfit can now safely estimate a yearly production of 15 miles of 18- to 20-ft. pavement as compared with less than half that mileage ten years ago. There has been no decrease in the number of reliable contractors during the past ten years but rather an appreciable increase, and the greater percentage have established themselves as reliable from the standpoint of organization, finance and performance. I repeat, there is no reason to doubt an available construction organization for a much increased program.

In the field of earth moving, a similar development has taken place. Ten years ago the slip scraper, wheel scraper and Maney scraper were the principal earth-moving units used, and while they are not yet entirely obsolete, they are at present relegated to very light work and clearing up shoulders and side ditches. The elevating grader is commonly used on jobs ranging from 5,000 to 10,000 cu.yd. per mile, and the elevating grader, steam shovel

TRACTOR-TRAILER TRAIN AND POWER SHOVEL GRADING OUTFIT

and dragline with such supplementary equipment as iron mules, and 5- and 6-yd. dump wagons hauled by tractors now predominate on the heavier grading sections. It is customary practice for the grading contractor to expect a yearly output of at least 100,000 cu.yd. per unit.

A separation of contracts into heavy grading, bridges and paving has developed many new contractors and permitted others to expand their organizations. There are many paving contractors who are unwilling to maintain a large grading outfit or a large bridge outfit. On the other hand, there are many excellent grading contractors who do not care to enter the paving field or engage in bridge work, and likewise there are bridge contractors who do not care to enter the field of either paving or grading. This separation of work into the three classes permits each type of contractor to become a specialist in his own line with a minimum overhead in equipment.

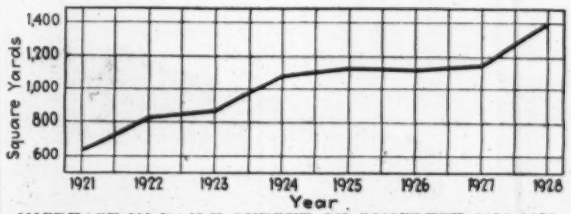
Engineering Organization

An analysis of the engineering organization of the Illinois Division of Highways offers the best conclusive evidence of the ability of any highway department to develop and hold together a nucleous which is capable of expansion to very wide limits. An examination of the employment record of the two administrative officers, eight bureau chiefs and nine district engineers shows an average of 15½ years of service in the department. A similar analysis of each district organization, considering the four principal assistants, shows 36 men with an average of ten years' continuous service with the department. This organization of 55 men is the nucleus and it is around them and through their activities that the entire organization of several hundred engineers functions.

Administrative officers and bureau chiefs encourage and contemplate frequent conferences with contractors, material producers and equipment manufacturers to discuss problems of mutual interest. The resident engineers and inspectors in charge of contract work are developed not only to recognize and require good work but to realize the contractor's viewpoint from a production and cost standpoint.

The year 1928, too, has demonstrated the ability of this engineering organization to expand. During the season it was necessary to employ nearly 300 additional engineers, and while there were a few misfits among these new men, yet from careful observation the work has been handled as efficiently as when only 50 per cent of that of 1928 was carried on. Certainly the immediate future should be taken care of in a similar manner.

MODERN AGGREGATE BATCHING PLANT



INCREASE IN DAILY OUTPUT OF CONCRETE 1921-1928

General Principles

There are certain basic principles which must be adhered to in any roadbuilding program, and these principles may be applied to every state irrespective of its size.

1. The construction program must not be isolated to certain portions of the state, but should be scattered throughout. This enables the utilization of all railroad facilities and the possibility of shipping from all the material sources. In addition, contractors are more or less locally situated and many do not care to make long jumps at large expense.

2. The desirability of having heavy grading and bridge work completed one or two years in advance of the paving work, which enables the paver to locate on the job and utilize a full construction season instead of spending two to three months of good weather waiting for the grading and culvert work to get out of the way.

3. Awarding of contracts early in the fall of the preceding year and at least before Feb. 1 of the current year. This invites a greater range of bids, since all contractors are looking for work at that time. In addition, it enables the contractor to keep his permanent organization, plan his sidings, arrange for the purchase of materials, get his culverts and grading under way and have the paver ready to start as soon as weather conditions permit.

4. The laying out of paving sections of such length as to provide a season's work for the average contractor. This may be done either by long sections or by combination bids.

5. An investigation of each contractor's financial ability and his previous construction record and the requirement that he file a progress chart showing his estimated progress and methods of operation.

Conclusion

As based on the accomplishments during the past ten years, it is the writer's opinion that:

1. It has been demonstrated that the material producers have developed an ample supply of cement and aggregates.

2. That the railroads realize and welcome this new source of revenue and have made arrangements to give preferred service and reasonable rates.

3. That the contracting organizations have increased in number, capacity and efficiency.

4. That the equipment manufacturers have been constantly developing new machinery and standardizing it.

5. That enough capable highway engineers have been developed.

6. And that each of these units can and will expand to meet an increased construction program.

Machinery's Part in Roadbuilding

In Ten Years It Has Doubled Rate of Output Without Increasing Investment or Operating Cost and Still Greater Results Are Ahead

By Lion Gardiner

Vice-President, Lakewood Engineering Company
President Manufacturers Division, American Road Builders Association, Cleveland, Ohio

THE accomplishment of the last ten years in roadbuilding equipment is perhaps the best indication of the sufficiency of the equipment manufacturer to rise to the extra demands of greater and more efficient roadbuilding in the future. Only the demand will limit the designer and manufacturer. Manufacturers today, through ten active years in building up their technical and production staffs, are better fitted than ever before to face any demand that the highway engineer and contractor may make. There are three parties, let it be emphasized, to any move or urge for improvement in equipment: first, the engineer; second, the contractor; third, the manufacturer.

Today roadbuilding is largely a machine operation. Almost every process in paved road construction of any type from rough grading to the final surface finish is mechanical. A machine even tells the engineer how great the roughness coefficient is per mile of finished pavement. This accomplishment has been due in large measure to the manufacturer. In performing it he has invested hundreds of thousands in experiments. In this article a manufacturer tells what equipment designers and builders have done and, more important, what they are prepared to do further to answer the call of engineers and contractors.

As a result of the progress of ten years (1) the engineer is obtaining smoother and better roads at a materially reduced cost; (2) the contractor has seen livestock and steam replaced by gasoline power, obsolescence replace a major portion of his equipment as larger production units became available, and less man power in combination with new equipment produce more than twice the former daily output; (3) the manufacturer has invested in new designs and experimental work hundreds of thousands of dollars more than in the previous decade, and has gone through a competitive era which has brought out the best engineering brains, with the result previously mentioned, that twice the daily production is possible today at about half the previous unit cost. As a further record of accomplishment on the part of production managers, one example suffices—namely, the 27-E paver of 1928 sells at approximately the same price as the 14-E paver of 1920.

Rough Grading

It is difficult to generalize on grading equipment, either present or future. In different sections of the country various viewpoints exist as to the best methods, and the trend toward improvement differs. Local conditions materially affect the equipment chosen. Under many circumstances, indeed, the identical methods of ten years ago are still used and are considered the most economical. In one section the slack-line method has given way to the small gas shovel and light motor trucks, and in another the elevating grader of years back has come into its own to a degree not previously known, and this too in conjunction with teams and wagons. The Missouri mule is not yet entirely on the obsolete list, though his general use has been affected by the tractor. In general large-unit contracts are now common, and single outfits handle larger yardages per month through the use of caterpillar tractors, tractor wagons mounted on crawlers and heavier self-loading wheelers suitable for tractor haulage.

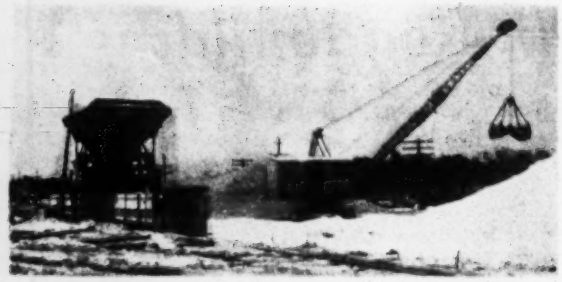
The small gasoline shovel and crane mounted on crawlers or motor trucks has found an important place in grading work. Relatively low-priced because of a yearly production almost ten times that in 1918, portable, fast and easily handled, it has been a surprise to the manufacturers themselves to find the great number that are absorbed by the industry each year. For each of the last three years the saturation point seemed possibly at hand, but yet new producers are coming into the field and finding outlet.

Specific changes can be noted in localities, but a general sweeping statement affecting the whole country can scarcely be made other than to point out the effect of the gas tractor handling larger units and the small gasoline shovel.

Fine Grading

The method of fine grading prior to laying the slab can be commented upon in a more specific way as being true the country over. With twice the daily slab being laid, with thickened edges practically universally specified and greater accuracy demanded by the engineer, the subgrader, a tool acting as both a templet and a cutting device, has come into general use as an essential part of the equipment of contractors desirous of lowest cost. In use in California prior to 1918, it was not until 1920 and thereafter that it was generally known or furnished

AN EARLY MECHANICAL UNLOADING PLANT



A MODERN UNLOADING AND BATCHING PLANT

to contractors east of the Rockies; now, however, not only for concrete slab, but for black-top pavements and city-street work, its use is steadily increasing. The power subgrader as well as the power form grader are further developments which in the next decade will no doubt play an important part.

At the contractor's material plant the problem of increasing daily capacity 100 per cent has been met with the gas crane. Hand handling to wagon loaders and derrick operation have given way to the crawler crane with ability to create and reach stockpiles as well as the car supply. The crude bins and measuring devices, all practically home made, are now supplanted by the portable steel bins with quickly operated accurate weighing hoppers. The present-day devices lend themselves to the closer proportioning of the aggregates and are not only a definite advance for the engneer but a proved economy to the contractor as well.

The use of bulk cement will probably increase in the future as the development of the small portable plant brings the initial cost within reasonable range. Here and there in past years and under proper conditions such a method of handling has shown possibilities.

The preparation of batches at the plant is universally giving better control and flexibility to the job. The light-batch truck and the heavy-duty three- or four-batch truck have been supplanted, the heavier unit in particular, by the high-speed, pneumatic-tire two-batch outfit, which seems better able in the long run to hold down the ton-mile cost. The average truck speed on the job today is 75 to 100 per cent greater than that of ten years ago, due to specialized design.

Narrow-gage car and batch-box operation still continues, though the number of new plants purchased is not numerous. It is, however, interesting to note that most of these plants first installed in 1919 or 1920 are still functioning economically and with probably higher average yield through all weather conditions than by any other method. A combination of narrow-gage railway and motor trucks is a development of the past seven years and still continues. This narrow gage operation is more or less centered in the Central West, where grades are more agreeable to their use.

On half-width construction, tractors drawing heavy trailers loaded with batch boxes, also trucks with flat decks and batch boxes mounted thereon, present an application seen in the East the past few years and are susceptible of further development. The desire to protect the subgrade will in all probability influence this trend.

The Mixing Plant

The 27-E paver, now the standard size for highway work determined upon by the Associated General Contractors and the Mixer Manufacturers Bureau in conference with highway engineers, will in all probability remain for some time. The average contractor's material yard and transportation system is strained to the utmost to average the 40 to 45 batches per hour possible with a one-minute mix; the present two-batch truck is near the limit of allowable tire loading in many states, and the heavy obsolescence charge and cost of a complete equipment change will act as a deterrent to a larger-size paving mixer unless it can be definitely proved that greater economy can be reached.

Pavers show the effect of automotive design influence, particularly in the later models. Gas power is now universal, as are high-duty roller bearings, alloy metals in snafts and gears and caterpillar treads. Automatic control of paving operation, first employed in 1922, is becoming more general, and further development may be expected, requiring perhaps a larger investment but giving the contractor a tool that will save seconds, keep going and reach a still higher peak of efficiency.

SUBGRADE FINISHER ON MODERN PAVING OPERATION

There were trends toward central mixing plants which seemed to fade, but now this activity has been very definitely revived with particular respect to city-street work. The transit mixer, by itself or in conjunction with the

WHEELBARROW GANG CHARGING MIXER FROM STOCK ON SUBGRADE

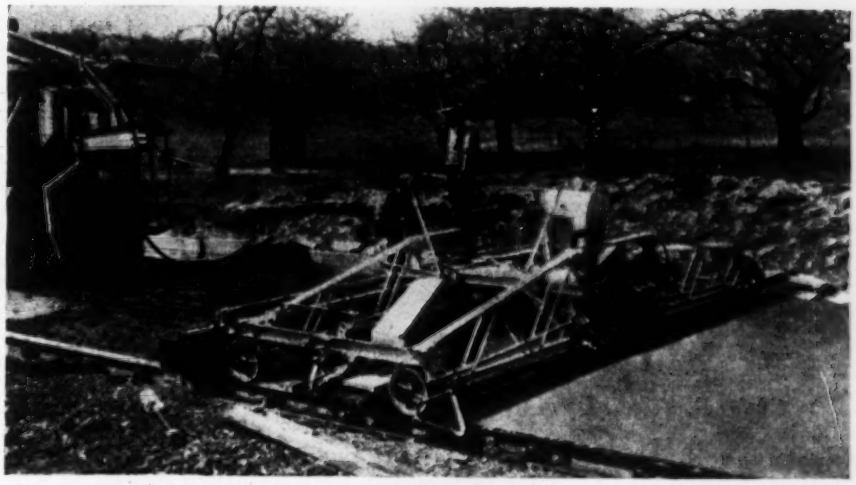
central mixing plant, is becoming a common sight, though not yet applied strictly to highway work. To forecast at present what the development may be is a considerable responsibility, but further experiments in the coming months will bear careful watching and study. Without doubt dependable concrete under rigid control can be delivered; the deciding factor in the final analysis will be based on relative economies. The situation presents a very live problem, which is having careful study by both manufacturers and contractors.

Improvements in finishing machines again show automotive influence with respect to design, and make 1,200 ft. per day as easy as was 500 ft. ten years ago. Greater widths are now available. The forms upon which they run were at first too flimsy and light. Now they have much heavier sections and more rigid joints. As a forecast, the present method of support can be improved upon through the use of secondary rails or heavier sections.

Hand tools and belts for additional surfacing work have changed but little, but there is a definite trend toward less mechanical disturbance of the concrete surface, and further improvement of mechanical equipment to produce a smooth, clean riding surface may be expected.

The latest application of the mechanical finisher has been to various types of asphalt surface and has met with remarkable success in a very short time. Time-honored theories have been thrown into the discard by prominent experts, and the coming year will see further extension of the use on asphalt of the standard concrete finisher or one with added attachments to bring about best results. In conjunction with this innovation and to obtain maximum economies an altered design of the well-known stone-spreader box is further cutting costs in spreading the hot material, and both together are producing a smooth surface of uniform consistency.

To sum up the progress of ten years, manufacturers now offer a plant to contractors and engineers which can produce practically double the output at approximately the same total investment and daily operating cost—not a bad record for this phase of American industry. And manufacturers have not reached the end of their ability to produce better equipment.



MODERN PAVER AND FINISHING MACHINE

Radio Used for Emergency Traffic Control

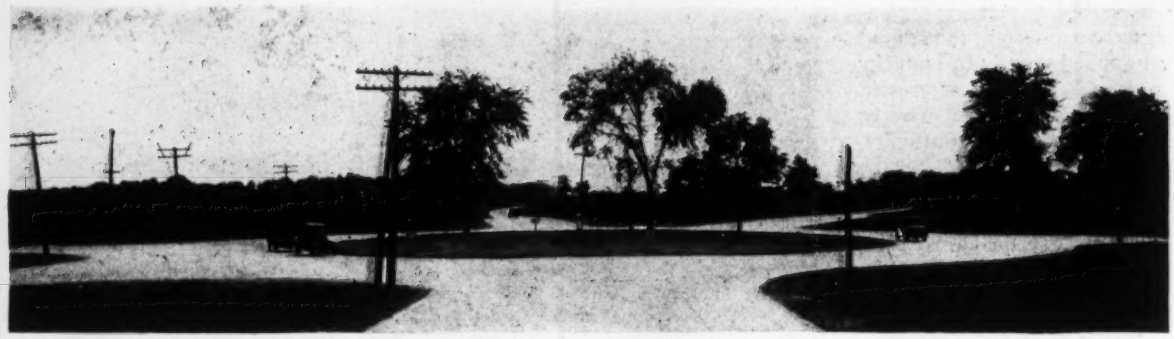
COLLAPSE of the Lincoln Highway bascule bridge over the Hackensack River in New Jersey Dec. 15 blocked without warning all traffic on one of the heaviest traveled roads in the United States. The nearest alternative highway crossing, 1½ miles away, was not accessible from the bridge site except by a long detour. Unusual importance, therefore, was attached to quick distribution of the news of the bridge collapse so that prospective traffic from the northeastern section of New Jersey would use alternative routes to New York City and four radio stations in the metropolitan district were broadcasting notices that the Lincoln Highway was closed within a few moments after the disaster.

Street Repairs by Direct Payment

NO DUTY of a city administration is quite so difficult to finance to the satisfaction of the citizen as street repair and maintenance. Particularly is this true if there is a substantial mileage of macadam pavement, as is the case in Chicago, where there still remains 9,529,000 sq.yd., equivalent to 697 miles. The greater portion of this mileage is old and badly worn, and legally cannot be repaired from the vehicle tax fund, since the repair and upkeep charges exceed the annual interest and depreciation on a new pavement. At the time it was put down the pavement was considered adequate, but motor vehicles now make short work of the best macadam. Yet on many of these streets where the pavement has been down many years the subsoil is well settled and there is yet a thickness of 10 to 14 in. of stone, adequate for normal residence-district traffic if only a smooth surface were available.

Since repair by the wheel-tax fund is not possible and the cost of new pavement by special assessment in Chicago is inordinately high, Richard W. Wolfe, commissioner of public works, has proposed to citizens owning property fronting on streets needing resurfacing the following unique procedure: The citizens must collect and deposit with the city or place in escrow sufficient money to pay the cost of resurfacing, the city using its asphalt repair gang and asphalt plant and charging the actual cost of $12 per ton delivered on the job plus the labor cost of preparing the street and laying the mixture. No charge is made for initial surveys and estimate of cost and for supervision or use of equipment. Costs run about $2.30 per yard or $4.10 to $5 per front foot for an average thickness of 2 in. of sheet asphalt, the larger holes being filled with binder. For new pavement by special assessment the cost may run to three or four times as much, since all the old stone has to be removed, usually new curb and gutter placed and manholes and inlets readjusted, in addition to overhead charges of 6 per cent each for legal and engineering services.

This procedure of bypassing the excessive new street cost cannot well be applied unless there is sufficient interest and leadership among the citizens affected to obtain a practical acquiescence to the plan, since there is no legal way to compel participation. However, already some requests have been received and next season a sizable mileage will be repaired by this method of financing.



Eliminate Signals by Rotary Circles

Serving the Traveler by

More Attractive Roads

Full Highway Service Includes Safeguarding Traffic, Adequate Lighting, Comfort Stations, Tree and Shrub Planting, Parks and Parkways

By Edward N. Hines

Member of the Board of County Road Commissioners, Wayne County, Detroit, Mich.

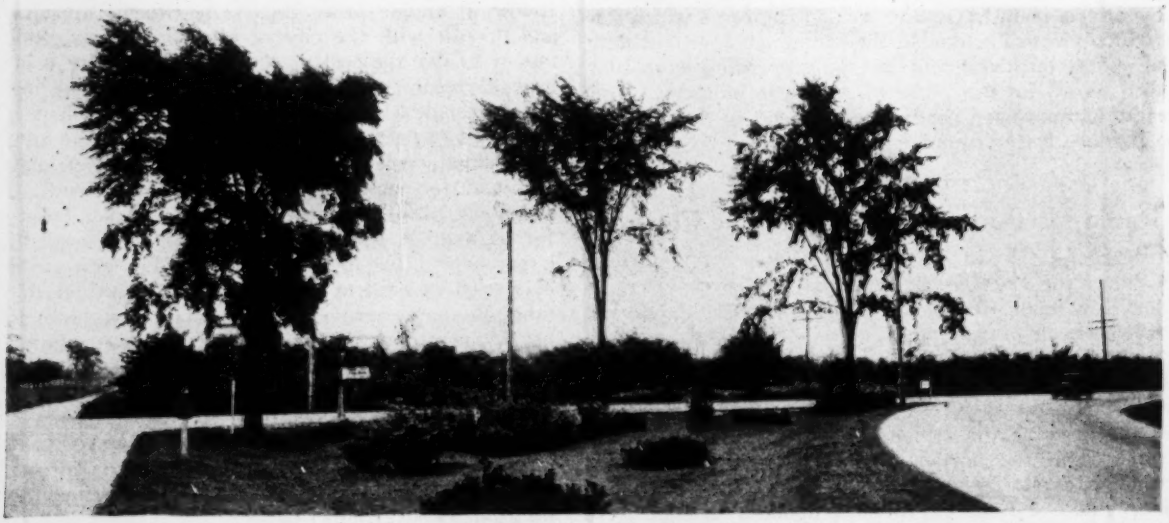
IT IS the duty of the road engineer to provide for those who travel the means to travel safely, conveniently, and with comfort. These necessities of road improvement include lighting, marking traffic lanes, signs, guard rails, tree planting, seeding and sodding, adequate detours, comfort stations, tourist camp sites, parks and parkways.

Safeguarding Traffic

The first necessity, next to a hard-surfaced roadway and its adequate right-of-way, is its associated safety measures. The best way to insure the safety of the public at crossings is to have grade separations. This is obviously and logically the only 100 per cent solution. The next best safety measure, where railroads and improved highways cross each other, is warning signal lights.

Signal Lights—In these days of closed cars and of buses and motor trucks equipped with cabs, the locomotive whistle and bell are inadequate means of warning. Red lights that operate automatically upon the approach of trains are the best warning signals at railroad crossings. If there is sufficient traffic to warrant an improved highway, then there is sufficient traffic to require warning signals. The best light is the one that tells the most. One that flashes the word "Stop" in large letters, as well as flashing attraction lights and ringing a bell, is a better type than one that flashes a single light.

Lighting the Road—There is more to safety lighting than railroad signals, road intersection lights, and "stop"



PLANT AND MAINTAIN SMALL TRIANGLES AT ROAD INTERSECTIONS

and "go" lights. The demand for highway lighting has shown a remarkable increase during the past few years and, as is the case with all reasonable public demands, it must be supplied.

Three general methods of highway lighting are recommended: overhead center suspension; lighting units placed on poles located in the center between two strips of pavement, and ornamental light posts with wires placed underground.

1. Overhead center suspension lights should be placed directly over the center of the pavement at a height approximately 30 ft. from the road surface. The lamps are suspended from span wires attached to poles placed on opposite sides of the pavement. The lights should be of 600 cp. and spaced from 350 to 400 ft. apart.

2. Two pavements are often separated by a parking strip, a space for electric railway tracks or a space reserved for future development, and each roadway carries traffic in one direction only. Poles may then be placed on the center line in the parking strip and the lights attached. These lights should carry reflectors that direct the rays with the traffic on each drive. Lamps of 600 cp. are recommended with a mounting height of 30 ft. and a spacing of approximately 115 ft.

3. Ornamental lampposts with underground conduits are of various sizes and types. Alternate spacing is most economical, because a more equal distribution of light is obtained and fewer posts are required. Ordinarily with this arrangement the posts should be approximately 200 ft. apart as measured on one side of the road. Lamps of 600 to 1,000 cp. should be used, with a minimum mounting height of 20 ft.

Pavement Marking—Traffic lanes and center lines painted on the pavement are further aids to safety. A wide white line in the center of the road serves to keep drivers on their proper side. Cross-strips painted on the pavement at a distance from 200 to 300 ft. from railroad crossings is also a common practice. A white line marking the stopping point at traffic lights prevents many from crowding to the center of the intersection. The plan of lines should be so simple that even he who drives fast may see and readily understand. Such lines are inexpensive to maintain.

Other Safety Measures—Concrete sidewalks or pedestrian paths should be built on main traveled roads, particularly those serving schoolhouses. Bridges should be constructed with a minimum clear width of roadway of 40 ft., with sidewalks in addition. Wood or cable guard rails should be placed along road shoulders, at the outside of all sharp turns and along heavy fills or deep ditches.

All shoulders should be at least of sufficient width to permit parking off of the traveled roadway. Pavements at all intersections should have an additional width of 20 ft. extending 200 ft. or more each way from the center of the crossing. A clear view for 250 ft. extending along a cross-road should be maintained at all intersections. A similar precaution should be taken at all railroad crossings.

Warning and information signs should be erected where needed. All roads should be properly marked with signs giving directions and distances to principal points, together with the name of the road. Such signs become more serviceable when adequately lighted. Night service is equally as important as is day service.

A safe and durable road structure is not complete highway travel service. It is due to the road user that his journey shall be comfortable and pleasurable. With this viewpoint many communities where travel is intensive and many states where tourist travel is sought are devoting thought to beautifying the road and to providing conveniences and attractions to travelers. Travel is coming to demand these refinements of road service and they must be considered in future roadbuilding. The article by Mr. Hines is a record of experience in a community where travel service has been carried farther than perhaps in any other place. It deserves the most careful attention.

Pleasuring Traffic

At least 60 per cent of the week-day traffic upon most improved highways can be considered as business traffic and the percentage is constantly on the increase. This is no reason, however, why everything should not be done by the road planner and the road engineer to make automobiling tolerable and pleasant.

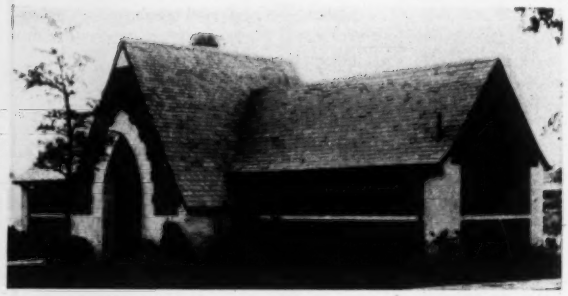
Tree Planting—Shaded highways are decidedly more comfortable in the hot weather than unshaded highways, as anyone who has driven over both kinds will testify. Ample room for tree planting and public utilities may be had through proper arrangement on widths of right-of-way of 66 ft. or greater.

Trees should always be planted as near the property line as possible, while poles should be placed between the trees and the pavement. The poles, of course, do not add to but rather detract from the beauty of the trees, but it must be remembered that all poles are temporary. Trees, if the proper species are selected, will live for many generations and their location must be permanent. Poles are also more easily moved than trees, and as the roads are widened or other utilities, such as underground structures, are installed, the available space near the pavement is filled. Trees are planted for their future use, and if the plan is properly carried out their present interference with pole lines will not be serious. If tree trimming is properly done for wire clearance, little or no damage results and pole lines may be located as close as 5 ft. from the center of the trees.

Shrubbery Plantations—Shrubs along the country roads is somewhat less important than trees, since they grow faster and produce a better showing in a shorter time. They may be used to advantage at the slopes of grade separations, bridge approaches and through heavy cuts and fills. They add much to the informal design of landscaping the highways when used at various locations along the roads.

The shoulders of all roads should be seeded. Slopes of banks through cuts and fills should be sodded. Sodded slopes at the approach to bridges and grade separations add materially to the appearance of the structures. Grass also helps to prevent erosion and costs less to maintain than bare spots or rock-filled washouts. The general maintenance of trees and shrubs should continue each year. It is desirable to give some attention to existing trees.

Comfort Stations—One of the most necessary aids to the comfort and convenience of the motorists is the construction and maintenance of roadside comfort stations. These should be fireproof, permanent structures and should conform to the rules of the local board of health or state board of health relative to water supply and sewage disposal. It is desirable that sufficient space be available around these buildings for parking and planting. They should also be architecturally attractive.



PROVIDE PRESENTABLE AND PERMANENT ROADSIDE COMFORT STATIONS

Tourists' Camps—The tourist should be furnished camping spaces and accommodations. Wayne County maintains a tourist camping site where parking space is provided, fitted up with a concrete stove, bench and table, garbage can and clothes line, safe drinking water and free air. A handsome tourist lodge is a feature of this camp site. Hot and cold shower baths and toilets are provided for men and women. There are a dining room with tables and chairs for use in inclement weather, individual gas plates where sufficient gas is provided to cook a meal by merely dropping a nickel in the slot, laundry tubs with hot and cold water, electric irons, pay telephones, a place to lounge, write letters, receive mail, check packages, etc.

Pleasure Drives—The demand for distinctive pleasure drives has led to the construction of rural parkways in many localities. More than ordinary highway development is involved, inasmuch as more land is required for park purposes. This form of highway construction is mostly near centers of large population, and the parkways in these instances serve as connecting links between large park areas.

Conclusion—Improved roads are not complete without these various aids and attractions in highway construction. The successful results obtained through nearly fifteen years of actual work by the Board of Wayne County Road Commissioners confirms this statement. The demand is constantly growing for wider roads, safer roads and roads made attractive and convenient by proper landscaping, installation of comfort stations and the regulation of public utilities.

Orderly and attractive roadsides are more easily maintained than those that are undeveloped. Well-kept roadsides are a benefit to abutting property owners as well as to the community at large.

Proportioning of Gravel Aggregate

THE National Sand and Gravel Association has recently installed a research laboratory at its Washington office under the direction of Stanton Walker. A series of investigations has been started to cover the following subjects: the effect of grading of sand and gravel upon voids, the effect of pea gravel upon the strength of concrete, the properties of washed gravel ballast, and special studies of specific concrete sands and gravels.

Voids in gravel play an important part in determining the quantity of cement required to produce a desired volume of concrete of given proportions. Some preliminary test results showing the effect of grading on voids in gravel have just been summarized by the association. By separating four different sizes of gravel and recombining in different percentages, the grading for minimum void space was obtained for the different combinations. Yield of concrete is of course greatest when voids are at a minimum, but this may not represent the best mix as regards strength. Further experiments will include studies of the transverse and compressive strength of the test pieces as well as yield.

New Mexico Experiments with Oiling Methods for Gravel Roads

By R. W. Bennett

Office Engineer, State Highway Department, Santa Fe, New Mexico

TWO methods of oiling gravel roads are being experimented with on seven sections of New Mexico highways, varying in length from 11 to 17 miles, in an effort to develop a standard maintenance operation for the 2,000 miles of this type of highway prevalent in the state. On four of the sections the mix-in-place or California "turnover" process is being used. The remaining three sections are being treated with oil and gravel premixed at a central plant.

Turnover Process—Prior to oiling, the entire project is resurfaced with crushed gravel from 6 in. to 12 in. in depth. Before applying the oil the surface is scarified to a depth of 3 in. over a width of 18 ft. After scarifying, the surfacing is treated with three applications of asphaltic road oil, the total unit application being 1.331 gal. per square yard. Following each application of oil, the material is thoroughly mixed with harrow and tractor and later with a motor grader. The mixing operations are very thorough, the oiled material being turned over or carried from one side of the road to the other by means of the motor grader until a uniform composition and color are obtained. After being mixed to a uniform consistency, the material is spread and allowed to compact under traffic. During the compaction process a blade is kept in continuous operation until the surface is firmly and smoothly hardened.

Exclusive of the cost of resurfacing the project with gravel, the total cost for labor, supplies, oil and equipment rental was $1,427.50 per mile, on one project, and $1,388.90 per mile on another.

Premix Method—By this process, the gravel surfacing material and oil are mixed at a central plant and the mixed material placed directly on the road, thus eliminating the scarification and mixing operations in the field.

MIXING WITH DISK HARROW AFTER APPLICATION OF OIL, "TURNOVER" PROCESS, NEW MEXICO STATE HIGHWAYS

This method is still in the experimental stage but it is proving successful and may prove more desirable than the turnover process.

The work is being done directly under the supervision of the state highway engineer. With the limited present funds available, New Mexico and other Western states are finding that the cost of maintaining their large amount of highway mileage is threatening to curtail construction operations.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Richard L. Humphrey—An Appreciation

Sir—In the death of Richard L. Humphrey, which occurred Nov. 2, 1928, the engineering profession suffered a great loss. Mr. Humphrey had for the past quarter of a century been most active in the affairs of engineering and technical societies. His energy and resourcefulness, together with his clarity of expression and convincing manner of presentation, made him a leader in many activities.

He was born in Marblehead, Mass., on Oct. 19, 1869. His family removed to Philadelphia and he received his education at the public schools of that city and at the University of Pennsylvania, from which he was graduated in civil engineering in 1891.

After holding several positions with railroad companies he was appointed assistant engineer in the bureau of engineering of the city of Philadelphia, where he was placed in charge of the testing laboratory, and here he began his life work—studying and developing cement and concrete as materials of construction. Under his leadership this laboratory became one of the most important municipal laboratories in this country and much valuable research work was carried on in it.

In 1899 he became engineer and general manager of the Buckhorn Portland Cement Works. During the ensuing four years he designed, built and operated this company's cement plant. Since 1903 he had been a consulting engineer and expert on concrete construction.

He was engineer in charge of construction of the reinforced-concrete building at the St. Louis Exposition. He assembled and erected the collective American portland cement exhibit and model testing laboratory of the American Portland Cement Manufacturers which received the grand prize at the Louisiana Purchase Exhibition in 1904. He served as cement expert of the United States Reclamation Service and as cement and concrete expert of the United States Geological Survey. He organized, planned and was engineer in charge of the government structural materials testing laboratories at St. Louis, Mo., Pittsburgh, Pa., Northampton, Pa., and Atlantic City, N. J., from 1905 to 1910.

He was chairman of the governmental committee appointed to investigate the effects of alkali upon concrete and reinforced concrete used in the construction of United States reclamation projects. In 1906 he also made an investigation for the government of the effect of the San Francisco earthquake and fire on structures and structural materials, which was published as a government bulletin. He established and designed the laboratory at Northampton, Pa., for the inspection and testing of the portland cement used in the construction of the Panama Canal and of which he was in charge until 1910. He was consulting engineer to the Bureau of Mines from 1910 to 1920. In 1908 and 1909 he was consulting expert in connection with the revision of the New York City building code.

During the World War he was appointed (Oct. 7, 1917) an expert on the raw materials committee, Council of National Defense, 1917-18. He was also appointed director of building materials and of the building materials division of the War Industries Board. He further served on the U. S. Highway Council, representing the War Industries Board, 1918. After the dissolution of the board at the close of 1918 he continued to act for the government in planning for the disposal of surplus building materials, in such a way as to give the maximum price return to the government and at the same time not unduly disturb the building materials market.

Mr. Humphrey was a member of many American and foreign engineering and technical societies and served as chairman or secretary of numerous committees and also as chairman of joint committees in several societies.

He was an outstanding character. His activities were numerous, his energy great. He achieved much in the field of engineering, especially in such organizations as the American Society of Civil Engineers, the American Society for Testing Materials and the Concrete Institute.

In the American Society of Civil Engineers he was a leader in the movement to establish local sections and in having them take part in the society's activities. He was deeply interested in the registration of engineers and served as chairman of a committee of the society to draft a uniform law upon this subject to be adopted in all parts of the United States. Such a law having been enacted in Pennsylvania, the Governor of the state appointed Mr. Humphrey chairman of the board to administer the law, which position he held from the institution of this board in 1921 until his death. He was largely instrumental in establishing the highest ideals for the engineering profession in the operations of the board.

In the American Society for Testing Materials and in the Concrete Institute Mr. Humphrey had a most important part in the development of cement and concrete specifications and was recognized as an authority upon these subjects.

Mr. Humphrey was a man of remarkable ability and of comprehensive good judgment and rendered many useful services in the engineering world. He was especially helpful in his contacts with young men entering the profession and was active in organizing student chapters in the American Society of Civil Engineers.

He was thorough and painstaking in everything he undertook, always an earnest advocate of the measures which he believed to be for the best interests of the engineering profession.

He was a stanch friend, a charming and lovable companion, and it was a privilege and inspiration to be associated with him. The loss of his influence and counsel will be keenly felt at future meetings of the societies of which he was a member.

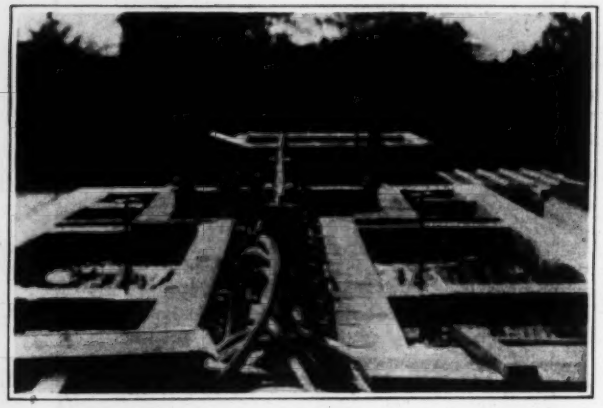
GEORGE S. WEBSTER,
Consulting Engineer.

Philadelphia, Pa.,
Dec. 21, 1928.

Submerged Brushwood Contact Aerators at Jacksonville, Tex., Sewage-Works

Sir—In regard to the article in *Engineering News-Record* of Oct. 18, 1928, p. 580, on "Submerged Contact Aerators for Sewage Treatment," by Karl Imhoff (translated by A. M. Buswell), describing certain German installations, it may be that your readers will be interested in a description of a submerged contact aerator which was designed as a part of the sewage-works at Jacksonville, Tex. This plant has been in continuous operation since Sept. 7, 1927, and is, as far as I know, the first municipal installation of a submerged brushwood aerator in the United States.

Raw sewage passes through a grit chamber, coarse bar screens and a preliminary settling chamber having one-hour retention period. Sludge passes to a separate sludge digestor and thence to glass-covered drying beds. The effluent from the preliminary settling tank enters a brushwood contact aerator having a one-hour retention period. After aeration there is a short settling period with sludge removal to the separate sludge digestor. The effluent then passes over a step aerator and into a dosing tank, where it is chlorinated. The dosing tank sprays the sewage over a coarse-grained trickling filter. The effluent from the trickling filter flows through a humus tank of Imhoff type, and finally down a step aerator of twelve steps and into a small stream having about half the volume of the sewage. The humus tank sludge is pumped into lagoons without creating a nuisance.



SUBMERGED SEWAGE CONTACT AERATORS AT JACKSONVILLE, TEX.

The contact aerator consists of a tank having precast containers with filtros plates laid side by side on the floor. The filtros plate area is one-third of the area of the water surface of the tank. Brushwood is supported on a Monel metal hammock over the filtros plates. Compressed air is introduced through the filtros plates and is evenly distributed throughout the brushwood colloider. Air is compressed by a positive pressure blower, and introduced under a total head of 4½ lb. The quantity of air delivered is equal to 0.25 cu.ft. per gallon of sewage and requires 3½ hp. The brushwood is laid in layers, some being parallel with and some crosswise of the flow of the sewage. Various woods have been used—pine, cedar, willow and oak. Experience during a year's operation led to these conclusions:

1. That the effect of contact aeration on settled sewage is largely physical—that is, colloidal suspensions are clotted and CO_2 and H_2S reduced. The clotted strippings from the brushwood, as well as normal growths of algæ, work upward and are carried over the weir to the second settling tank.

2. The clotted product settles readily at a downward rate of 4 in. per minute in a quiescent state.

3. Grease is held on the surface of the tank and gravitates to the edge of the tank, where it can be removed.

4. The finer the brushwood the better and more extensive the clotting. Willow is preferred.

5. No odors other than of grease can be noticed over the aerator tank. Odors in the neighborhood that may be noticed are from the primary settling tank and dosing tank.

6. Air at the rate of 0.25 cu.ft. per gallon of sewage is just sufficient to agitate the surface violently and blow off strippings.

7. Protozoa are conspicuous by their absence in subsurface growths. On the surface, protozoa exist. Algæ and photo synthetic action are usual on the surface brushwood. Sprouting of willow branches has occurred on the surface. The zone of purification is mesosaprobic Alpha and, sometimes, Beta.

8. There is a rise in pH from 7.1 to 7.5 and dissolved oxygen is increased from zero to 0.5 p.p.m.

9. The settlings in an Imhoff cone, after one hour, show an increase in actual volume, but this is largely due to the high water content of the sludge, which is very much higher than that of raw sewage or settled sewage.

10. The sewage is partly activated, and sludge rapidly becomes unstable and should be removed by drawing off to the separate sludge digester.

11. The value of the aerator as a treating unit is about equal to that of a small contact bed, and has about one-fourth the effectiveness of a trickling filter under normal rates.

12. The fine strippings that get by the secondary settling tank are not retained on the trickling filter but are washed on through into the humus tank, where they are partly settled out, but they often flow over the weir and into the stream, and if not flushed out by diluting water, will shoal up and breed flies.

13. For best results, secondary settling tanks having at least at 1½-hour capacity should be provided where contact aerators are used. No re-aeration or pumping back sludge is required as in activated sludge.

14. Bacteria alone seem to be the oxidizing agents, unlike the trickling filter in which protozoa play an important rôle.

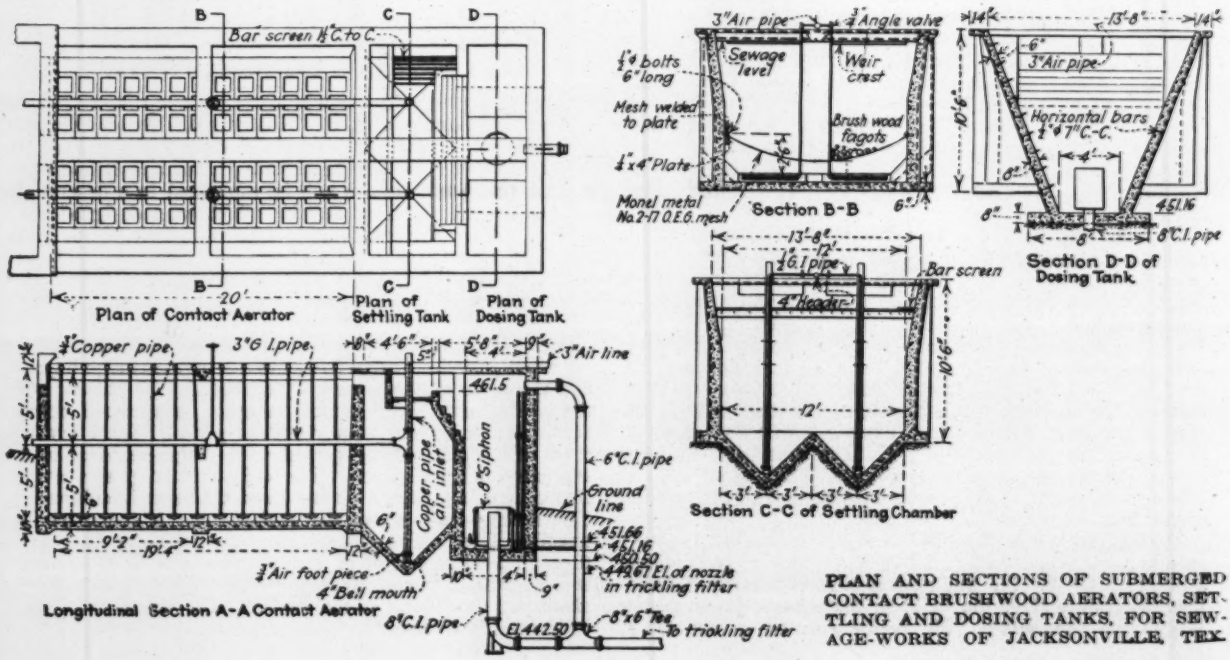
15. No B.O.D. tests have been made. A complete study of the colloids using Tyndall cone apparatus would throw more light on the physicochemistry of the subject.

From my experience I should say that the value of contact aeration would only be one where partial treatment is desirable. As a forerunner of trickling filters, I should prefer a coarse-grained roughing filter, provided sufficient head were available. Straight activated sludge of twenty-minute aeration period would be just as satisfactory for a preliminary treatment.

The plant was designed by the writer to handle 400,000 gal. per day, and was constructed under his supervision, using day labor instead of contract work.

Jacksonville, Tex.,
Nov. 5, 1928.

H. L. THACKWELL,
Consulting Engineer.



PLAN AND SECTIONS OF SUBMERGED CONTACT BRUSHWOOD AERATORS, SETTLING AND DOSING TANKS, FOR SEWAGE-WORKS OF JACKSONVILLE, TEX.

News of the Week

Board of Engineers Recommends Raising Aswan Dam in Egypt

An international board of engineers, consisting of Hugh L. Cooper, New York, W. J. E. Binnie, England, and H. E. Gruner, Switzerland, has recommended to the Egyptian government that the Aswan dam be raised 9½ meters in order to add greatly to the storage of the present reservoir. The proposed work will cost approximately $12,000,000, and the board recommends that it be carried out over a period of three years as proposed in a study made by Sir Murdoch MacDonald.

The board was called in by the Egyptian government to review three separate schemes for raising the dam but was authorized to submit its own proposals if none of those under consideration seemed satisfactory. The proposals made by the board differ from any of those previously submitted. They will be given in more detail in a subsequent issue.

Mr. Cooper, who has just returned to New York, states that in view of the fact that the report of the commission was unanimous, the first instance in which any report on the Aswan dam has been unanimous, the Egyptian government will adopt its recommendations and put the work under contract in the near future.

New York-Boston Toll Highway Proposed by Corporation

A private toll road from New York to Boston to be built at an estimated cost of $85,000,000 is proposed by the New England Express Highway Company. The next General Assembly of the State of Connecticut will be petitioned for a charter to build and operate the road.

The backers of the road claim that with the present highways already congested and highway traffic increasing at a rate of 10 per cent a year, such a toll road as proposed is desirable. It is expected that the highway, if built, will be under the control of the Public Utilities Commission, and the charter will contain a clause for ultimate reversion to the states.

Tennessee Tunnel Opened

A new tunnel through Chattanooga Mountain at Tunnel Hill, Ga., has been opened by the Nashville, Chattanooga & St. Louis Railroad, replacing one opened in 1849 which has become inadequate to meet traffic demands. The new tunnel, which is 1,513 ft. long, cost approximately $500,000. It is on the old Western & Atlantic Railroad, which has been leased to the Nashville, Chattanooga & St. Louis.

Federal-Aid Roads to Get $73,125,000 From Agriculture Department

Secretary Jardine Makes Apportionment for Next Fiscal Year—10,198 Miles Aided Last Year

SECRETARY of Agriculture Jardine has announced the apportionment of $73,125,000 to the states as federal aid in road construction for the fiscal year which begins next July 1. This apportionment has been authorized by Congress for continuing the federal-aid program, and the funds will be expended according to the same provisions which have governed past expenditures, that of the states meeting the federal appropriations dollar for dollar.

During the last fiscal year improvements were completed on 8,184 miles of federal-aid road which had not previously been improved with federal assistance and advanced stages of improvement were completed on 2,014 miles. The apportionment is as follows:

Alabama	$1,554,221	Nevada	960,375
Arizona	1,061,111	N. H.	365,625
Arkansas	1,284,382	New Jersey	937,434
Calif.	2,495,345	N. M.	1,189,085
Colorado	1,388,755	New York	3,617,748
Conn.	477,110	N. C.	1,716,919
Delaware	365,625	N. D.	1,197,586
Florida	909,235	Ohio	2,754,446
Georgia	1,980,443	Oklahoma	1,748,857
Hawaii	365,625	Oregon	1,191,989
Idaho	933,902	Penn.	3,325,854
Illinois	3,118,949	R. I.	365,625
Indiana	1,917,036	S. C.	1,061,447
Iowa	2,020,861	S. D.	1,229,282
Kansas	2,058,305	Tenn.	1,609,662
Kentucky	1,417,634	Texas	4,531,162
Louisiana	1,026,696	Utah	848,592
Maine	678,501	Vermont	365,625
Maryland	633,615	Virginia	1,433,405
Mass.	1,090,077	Wash.	1,149,489
Michigan	2,204,966	W. V.	796,408
Minnesota	2,108,104	Wis.	1,854,580
Mississippi	1,311,391	Wyoming	939,536
Missouri	2,392,021		
Montana	1,554,060		
Nebraska	$1,586,299		$73,125,000

Mid-Hudson Bridge Caisson Sunk to Final Position

The east caisson of the Mid-Hudson bridge under construction at Poughkeepsie, N. Y., has been entirely righted and sunk to final position, 135 ft. below water level, after suddenly listing 43 deg. during dredging operations about a year ago. The caisson, 60x136 ft. in plan, consists of 25 open dredging pockets, of which fifteen have been concreted to the top, a height of 104 ft. Construction operations have now closed down for the winter.

The final position of the caisson is 10 ft. west of that originally intended, and as a result the length of spans will be changed 5 ft. The Blakeslee-Rollins Corporation, contractor on the piers, performed the difficult righting operations.

Additional Vehicular Tunnel Proposed for New York

A proposal that a second vehicular tunnel under the Hudson River at New York be built in the immediate future has been made by the chairmen of the New York and New Jersey bridge and tunnel commissions to the new Governors of the two states. Immediate construction of a tunnel somewhere between 34th and 42nd Streets is proposed and a future program is outlined for tunnels in the neighborhood of 14th, 59th and 125th Streets, New York.

Construction of the proposed tunnel near 34th Street is estimated to cost $48,000,000 and the commissions propose that in so far as New York State is concerned its portion of the income from the Holland Tunnel be turned into a revolving fund for the construction of this and other vehicular tunnels. The portion of the Holland Tunnel income going to New Jersey must be used to retire bonds issued for the construction of the tunnel.

The New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission were appointed by the state legislatures for the general purpose of building bridges or tunnels across the Hudson River at New York. When they had agreed upon the construction of the Holland Tunnel funds for that specific purpose were raised by the state legislatures. They have no bond-issuing authority.

Central Pacific R. R. Will Build Extension in California

Approval has been given by the Interstate Commerce Commission to a proposed extension of the Walnut Grove branch of the Central Pacific Railway from Walnut Grove to Isleton, Calif., 8.6 miles. Construction is to be commenced on or before April 1, 1929, and will be completed in one year. The cost is estimated at $700,000.

Richmond's Tallest Structure to Be 21-Story Bank Building

Plans have been completed for a 21-story building for the Central National Bank of Richmond, Va., which will be the tallest structure in the city. The building will be located on the south side of Broad St. between Second and Third Sts., and will have the lower floors devoted to banking space, with the remaining eighteen floors for offices.

Construction contracts are expected to be called for some time this month. Carneal & Johnson, Richmond, are architects on the building, with John Eberson, New York City, as associate.

Remedial Works at Niagara Falls to Be Constructed

Negotiations looking toward the execution of a treaty between the United States and Canada for the construction of remedial works in the rapids above the cataract at Niagara Falls are about to be completed. The proposed works have been approved by the Chief of Engineers, and nothing remains now to be done but the formalities of signing the treaty.

An abstract of the report of a special international board to study conditions at Niagara Falls and recommend that changes should be made in the rapids was given in our issue of Feb. 23, 1928, p. 332. The report of this board was never given out in full by the State Department, but was made public in both Canada and Great Britain. The board recommended the construction of submerged weirs in the rapids and the enlargement of certain channels in order to distribute the flow of water over the Falls more uniformly and at the same time make more water available for diversion. The board estimated the work to cost $1,750,000. Apparently a lesser amount of work is contemplated in the proposed treaty, as its cost is estimated at about $1,300,000.

Florida Seeks Federal Control of Lake Okeechobee

Several petitions have been received in Washington from inhabitants of the Lake Okeechobee section of Florida urging the government to pursue a more liberal policy in its treatment of flood-control problems in southern Florida. The petitions urge that the serious nature of the floods experienced from Lake Okeechobee in 1926 and in 1928 (the latter, it is stated, causing more loss of life than any other recorded disaster in the United States) calls for an investigation of the district with a view to flood control, navigation, reclamation, drainage and irrigation under federal auspices. It is further stated that the State of Florida has not sufficient funds available for any further work in an Everglades drainage and flood-control project.

New York Plans Zone for Retail Business Exclusively

Amendment of New York City's building zone regulations to create a new type of restrictive zone to be known as a retail district is provided for in a resolution adopted by the Board of Estimate and Apportionment. Public hearings will be held on the proposal before any final action is taken. The proposed amendment provides that in such retail districts no manufacturing or treatment of products shall be carried on other than such as is incidental to the conduct of a retail business. It is proposed to establish the first of these retail districts in the area between 23d and 50th Sts. and Park Ave. and a point 100 ft. west of Eighth Ave.

Rocky Mountain Highway Engineers Meet at U. of Colo. Jan. 24-25

Highway engineers and others interested in road construction in the Rocky Mountain region will convene for the third annual highway engineering conference at the University of Colorado, Boulder, Jan. 24-25. Representatives of the U. S. Bureau of Public Roads; the state highway departments of Wyoming, Colorado and New Mexico; the Colorado Municipal League, and others will participate in the conference. Papers will be presented on many subjects peculiarly applicable to highway construction and maintenance in the Rocky Mountain territory.

Highway problems of the Rocky Mountain States present features which justify separate consideration from that accorded to similar problems in other sections of the country. Large areas, great distances, sparsely populated regions and limited funds give highway problems in this region aspects different from those commonly encountered elsewhere in the United States.

St. Louis Formulating Plans for Rapid Transit System

The St. Louis, Mo., Transportation Survey Commission is about to begin a comprehensive survey of the city as an aid in planning a rapid transit system for the city and its environs. The work will be in charge of Rudolph F. Kelker, Jr., of Kelker, De Leuw & Co., Chicago, who has had experience with transportation problems in Los Angeles, Baltimore, and other large cities. Mr. Kelker was selected from a list of nineteen engineers submitted to the commission. Work on the survey will start immediately.

First Train Through Cascade Tunnel to Be Run Jan. 12

The first train through the Great Northern Railway's Cascade tunnel will be run Jan. 12, following opening ceremonies. At the same time 75 miles of main-line trackage will be changed from steam to electric operation, completing electrification through the entire Cascade range. Regenerative braking will be used in the operation.

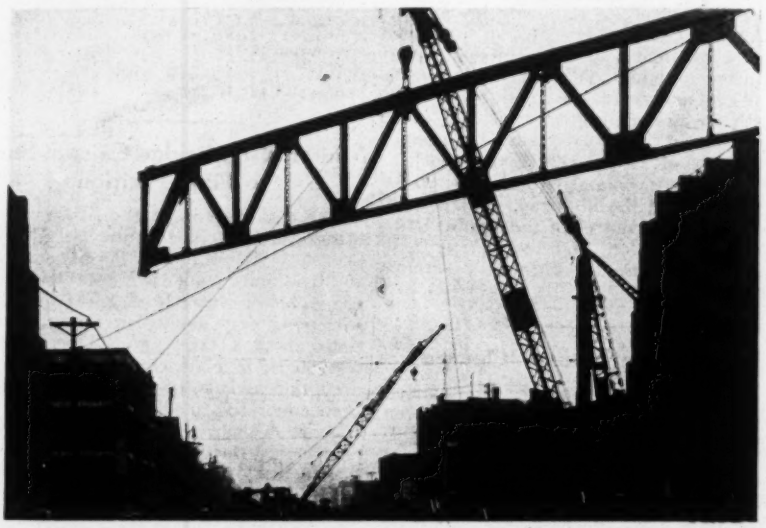
Construction of the tunnel cost $14,000,000, while additional cost of necessary equipment brought the total to $25,000,000. Power will be taken from overhead catenaries at 11,000 volts alternating current and transformed within the locomotives to low-voltage direct current.

King Edward Pier in Montreal Harbor to Be Strengthened

The Canadian Department of Marine and Fisheries has awarded a contract to the Foundation Company of Canada for reinforcing the supports of the King Edward pier in Montreal harbor, which are giving way. About 140 steel cylinders will be sunk outside the existing supports, and the intervening space filled with crushed stone. The top of each cylinder will be covered with a concrete coping, bring the whole to the level of the present pier floor, which will be extended to the new portion of the pier. The work, it is expected, will call for an expenditure of more than $500,000.

Difficult winter work on the construction will be necessary for completion before the navigation season opens. Dredging will also be carried on in the basin, and it is expected that a minimum depth of 35 ft. will be attained before the opening of the season.

PLACING A TRUSS OF THE DETROIT BRIDGE APPROACH



Part of one span of the Detroit approach to the Ambassador bridge, which will connect Detroit with Canada, is shown being placed in position 90 ft. above the street level. The truss being hoisted is 140 ft. long and weighs 60 tons. It is expected to open the bridge to traffic next July.

Olean Water-Borne Typhoid Caused 20 Deaths

Tentative figures on the Olean water-borne typhoid outbreak, noted in *Engineering News-Record* of Oct. 18, 1928, p. 600, place the number of cases up to about Dec. 15 at 227, with twenty deaths. These figures, *Engineering News-Record* is informed by H. F. Senftner, associate director, New York State Department of Health, under date of Dec. 15, are incomplete.

A report based on an investigation by the state health department, submitted to the local authorities on Nov. 9 and printed nearly in full in the department's *Health News* for Nov. 26, lays the epidemic to a broken water main, laid beneath the Allegheny River at a point below a city outlet sewer. The report states that "several thousand cases of diarrhea," occurring prior to the middle of August, "were not reported to" Albany, "as required by the state sanitary code"; also that had "daily tests for excess chlorine been made, as recommended by the department," the need for increasing the chlorine applied "would immediately have been noted."

The department advises the earliest practicable abandonment of the South Olean pumping station (which delivered the polluted water, drawn from wells held in reserve), also that the North Olean filter plant be enlarged and that two chlorinators of larger capacity than those in use be installed. Further advice is that the city employ experienced operating personnel for its water-works and sewerage systems; that the county supervise all water-supply and sewage-disposal facilities (within the county?); and that the city should build an intercepting sewer and sewage-works.

Resignations of the three water commissioners and health officer have been received and successors appointed by the city council. One of the new water commissioners is E. H. Atwood, designer of the Olean water filters.

Notice of action against the city to recover $5,000 damages has been filed, says *Health News* of Dec. 17, by the administrator of the estate of a Buffalo resident, alleged to have been a victim of the Olean epidemic.

Civil Engineers to Meet Soon

The seventy-sixth annual meeting of the American Society of Civil Engineers will be held in New York City Jan. 16-18. The usual business of the annual meeting will be transacted, including the presentation of reports of the secretary, the treasurer and the board of directors. The newly elected president of the society will be presented, and honorary membership will be conferred on J. Waldo Smith, consulting engineer of the New York City Board of Water Supply. Special committees which will report are as follows: On concrete and reinforced-concrete arches; on steel column research; on impact in highway bridges. Reports will also be presented on the status and progress in the art of city planning, highway engineering and waterways engineering.

Thursday, Jan. 17, will be devoted to meetings of the various technical divisions, including the highway, sanitary engineering, structural, surveying and mapping, construction, city planning and power divisions of the society. A boat excursion to various bridges under construction in the vicinity of New York, including the new Hudson River suspension bridge, is scheduled for Friday, Jan. 18. The following morning will be devoted to an inspection trip through new subways now being built in New York City under contracts aggregating $240,000,000.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Boulder Dam Chief Engineer Not Appointed Yet—General Dept. Administration Proposed

CURRENT reports that R. F. Walter, chief engineer, Bureau of Reclamation, would be in active charge of construction of the Boulder dam are unauthentic. Dr. Elwood Mead, Commissioner of Reclamation, states that no thought has been given to the selection of the man who will be in immediate charge of the work. Mr. Walter's connection with the project will be of the same general character as it is toward all other projects being handled by the bureau. Were he to be chosen for the place it would mean that he would have to devote his entire time to that project and a new chief engineer appointed. No such step is under contemplation. While Dr. Mead refuses to speculate on the policy which will be followed in the construction of this dam, it is believed that the work will be placed under the immediate supervision of one of the bureau's own engineers, or an engineer who formerly has been in the bureau's service. It is regarded as practically certain that some outstanding engineer outside the service will be retained in a consulting capacity.

Department of General Administration

A proposed national department of general administration was discussed at a meeting of the American Political Science Association in Chicago Dec. 27. The plan was outlined by W. F. Willoughby, director of the Institute for Government Research, whose organization has been active for many years in studying possibilities for governmental improvement. Numerous organizations, including the American Federation of Labor and various groups of economists, federal employees and others interested in the problem, have given informal support to the plan and aided in formulating its details.

The need for an administrative department is based on the contention that the President, though clothed with far-reaching powers, is hampered by the difficulty of obtaining adequate information on which to base his decisions. If he is called upon to lay down policies covering a large project to be undertaken by one of the departments, there is no present agency to investigate and sift the findings properly, it is argued. The remedy does not contemplate new employees but rather the co-ordination of the five agencies which are now working along similar lines in different ways. These are: the Bureau of Budget, the Bureau of Efficiency, the Civil Service Commission, the Personnel Classification Board representing the above three organizations, and the General Supply Committee, which could be taken as the nucleus for a government purchasing agency.

While apparently separate in function, these organizations overlap to a large extent. If, for example, a department reports to the Bureau of Budget that a given sum is needed for authorized work, the bureau must find out whether this sum is in fact necessary, whether the department is getting personnel and equipment satisfactory for the purposes, etc. The Civil Service Commission is interested in much the same matters in its relation to the same piece of work. The investigating and controlling of appropriations, personnel, administration, supplies, equipment, organization and procedure are so interwoven that it is impossible to oversee them through several independent groups without a co-ordinating body over them, it is contended. Whether the merged organization should be a bureau, commission or separate department with a new Cabinet officer is not considered the main problem.

The investigating personnel would be of three types: groups knowing the needs of the different departments, trained experts such as chemists, engineers and other technical men competent to pass on the merits of a given plan, and regional representatives thoroughly familiar with their districts. Such a body would, it is pointed out, provide information for intelligent administration and eliminate present abuses arising through the control of bureaucrats lacking in experience of field conditions.

River, Harbor and Highway Projects Not Affected by Treasury Deficit

A very determined effort is being made by the Bureau of the Budget to prevent a Treasury deficit. The endeavor has gone to the extent of requiring federal agencies to withhold the expenditure of money already appropriated. This will not affect river and harbor and highway projects, as the agencies in charge of that work have authority to make contracts in advance. In connection with those projects there would be no difficulty in making arrangements with contractors to go forward with the work, with the understanding that they wold not be paid until after July 1, when the new fiscal year begins.

Indianapolis Belt R.R. Asked to Elevate Tracks

Notice to the Indianapolis Belt Railroad to begin its track elevation program has been issued by the Indianapolis board of public works. A resolution informing the railroad that the city has let all contracts and provided money for the flood-prevention program was adopted by the board. A contract existing between the city and the railroad provides that the latter begin its track elevation program within 30 days after the city has let all contracts for the flood-prevention schedule. The Belt elevation will begin on one end of the system and extend in a semicircular sweep around the city at a cost approximating $10,000,000.

Electrolysis and Soil Corrosion of Water Pipe

A survey of stray electric currents before the construction of a new water-supply main at New Haven, Conn., was the subject of a paper by E. E. Minor, general manager, New Haven Water Company, at the luncheon meeting of the New York Section of the American Water Works Association, New York City, on Dec. 28. The survey was made by the Albert F. Ganz Company, New York City, under the direction of Charles F. Meyerherm. The proposed pipe line was to be of cast iron, 48 and 42 in. in diameter, which for some 5 miles of its length paralleled an interurban electric railway line which showed that earth current conditions demanded changes in the provision for the return of current to the power station.

In opening the discussion on this paper Mr. Meyerherm described an earlier survey of somewhat similar character, made in the Adirondacks section of New York State, where a gas main was to be laid parallel to the electric railway. Conditions were found to be such as to lead to the use of insulating joints. These added about 1 per cent to the construction cost of the pipe line. W. W. Brush, chief engineer, Department of Water Supply, New York City, said that there had just been spent under his direction some $13,000 for the repair of pittings on a steel pipe line. Allen Hazen remarked that in the South and West cement joints are used in cast-iron pipe-line construction and seem to afford complete protection against electrolysis. He supposed that leadite would do the same.

A brief summary of the findings to date of the soil corrosion survey now going on throughout the country was given by Mr. Logan, electrical engineer of the U. S. Bureau of Standards. Specimens of pipe and other metal buried in 1922 have been examined at two-year intervals since then. From the pipe samples alone it cannot be told whether any corrosion which is found is due to the soil or to electrolysis. In general, as among different kinds of ferrous pipe, soil corrosion affects one kind as much as another. Mr. Logan said that, so far as known, there has been no research on the effect of corrosion on bituminous coatings for pipe, but some are proposed by the Petroleum Institute. A corrosion congress was held at the office of the Bureau of Standards in December, and some 34 papers were read.

Request Approval of New Railway Express Plan

Application has been made to the Interstate Commerce Commission for approval of an operating agreement, to go into effect March 1, 1929, between the principal railroads of the country and the Railway Express Agency, Inc., for the future conduct of the express business as agent for the railroads. The operating agreement, according to the application, involves a pooling arrangement for division of earnings of the participating railroads. It is proposed to acquire and vest in the Railway Express Agency, as agent for the railroads, the properties of the American Railway Express Company.

Brief News

A COFFERDAM with a total length of 4,300 ft. is now being built at St. John, New Brunswick, in connection with the $5,000,000 harbor development, which includes the construction of a pier 1,250 ft. long by 300 ft. wide and an elevator with a capacity of 2,400,000 bu. Ultimate plans call for a total expenditure of approximately $10,000,000.

ERECTED to provide for the medical and dental profession, the new twelve-story Paulsen building at Spokane, Wash., is now approaching completion at a cost of approximately $1,000,000. Facilities provided include compressed air supply, gas, alternating and direct electric current, a complete hospital, an auditorium to seat 160 and a garage for 70 cars. The Rounds-Clist Company, Spokane, is the general contractor.

CORE DRILL TESTS of 30 miles of pavement laid in Syracuse, N. Y., this season have resulted in recommendations by the city engineer that certain contractors be required to relay some pavements. Out of 23 samples taken, the report of the city engineer states, only four showed the required depth of 8 in. Five of the cores had a total depth of only 3 in.

THE MISSOURI PACIFIC BRIDGE across the Arkansas River at Little Rock, Ark., will be completed about Feb. 15. Work on the last truss span has been begun, leaving only the lift span still to be erected.

APPROVAL has been given by the Pennsylvania State Water and Power Resources Board of a proposed inter-county bridge across the Susquehanna River between Columbia and Wrightsville, Pa. This will be a $3,000,000 structure 1½ miles long. The only bridge at present is owned by the Pennsylvania Railroad and is used by vehicular traffic between trains.

A NEW RAILWAY is planned in British Columbia to connect Telkwa with the Pacific Ocean. An application for permission to construct the line is now before the railway department of British Columbia.

A WATERWHEEL 115 years old at Greensville, Ont., was recently repaired and once more placed in service. The trouble was caused by a broken axle.

THE PACIFIC RAILWAY of Argentina expects to spend about $42,100,000 in new improvements. A new terminal for Buenos Aires and the construction of an elevated roadway, 610 meters long and 35 meters wide, through the city are part of the work to be done.

THE SUIT TO DECLARE INVALID bonds issued for the building of the Moffat tunnel in excess of the $6,720,000 approved by the voters has been appealed to the Colorado Supreme Court for decision. The action of the Moffat Tunnel Commission in issuing the excess bonds was sustained by a lower court, as reported in *Engineering News-Record*, Nov. 1, 1928, p. 670.

Personal Notes

W. H. PETERSON, engineer of maintenance-of-way, Rock Island Lines, Des Moines, Iowa, has been appointed chief engineer of the system to succeed C. A. MORSE, who retired Jan. 1. Mr. Peterson has been with the Rock Island in various capacities since 1906, having previously served with the Union Pacific, Great Northern, Northern Pacific and Chicago & Northwestern railways.

E. A. OLSEN has assumed the executive vice-presidency of the Pacific Public Service Company at San Francisco into which has been consolidated control of the Coast Counties Gas & Electric Company and the California Consumers Company. He is also vice-president of the United States Engineering Company, which supervises the operation of the properties. Mr. Olsen was formerly executive vice-president of the Florida Power Corporation with headquarters at St. Petersburg.

B. M. RICHARDSON, Cedar Rapids, Ia., became chairman of the Iowa state board of railroad commissioners on Jan. 1, succeeding CHARLES WEBSTER.

ROBERT S. SUMNER has resigned as general manager of the Denver Water Department. HIRAM HILTS, secretary of the department, is acting as general manager.

GEORGE A. ORROK, for a number of years consulting engineer to the New York Edison Company, has severed his connection with that company and has opened an office at 52 Vanderbilt Ave., New York. Mr. Orrok will specialize in steam and hydro-electric power, in mechanical equipment and in gas and coke production.

Engineer in Mexican Cabinet

President Portes Gil, of Mexico, has named Engineer Javier Sanchez Majorada as Secretary of Communications and Public Works in his newly formed Cabinet. Mr. Mejorada was born in 1886 in Pachuca, State of Hidalgo, Mexico. He graduated in 1906 from the National School of Engineers at Mexico City, entering the service of a large mining company as assistant to the superintendent of construction. Later he served as an irrigation engineer in the states of Coahuila and Durango, with principal work in the Nazas River Irrigation District, where he enlarged the Santa Rosa irrigation project, of which he was manager. After this, he entered private practice as consulting engineer. During the revolutionary conditions in Mexico Mr. Mejorada managed irrigated properties in his home state. In 1921 he was called by the Mexican government to take the position of irrigation engineer of the first zone, including Lower California and Sonora. In 1926 he was appointed by President Calles as commissioner on the National Irrigation Commission of Mexico. Two projects of the commission, El Mante and the Don Martin, are now approaching completion. In addition to this work Mr. Mejorada is also a member of the International Water Commission for the United States and Mexico. He has visited many of the larger irrigation projects of the United States and is an authority on colonization projects.

Obituary

WILLIAM C. BOWLES, for 52 years engaged in enginering and grade-crossing elimination work for the Pennsylvania Railroad, died Christmas day at his home in Elizabeth, N. J. During the war he was in charge of the construction of the Port Newark terminals which were being built to relieve the heavy freight congestion at the Pennsylvania's eastern terminal. Mr. Bowles was in charge of the reconstruction work of the railroad in the Johnstown, Pa., district after the disastrous flood. He was 73 years of age and had retired from active service in 1925.

WILLIAM GARROW FISHER, once prominent in the steel industry, died at his home in Lyndhurst, N. J., Dec. 16, at the age of 72.

JONATHAN STEWART, for 40 years a building contractor in Indianapolis and vicinity, died recently at his home in that city.

BURTON C. DOWNING, president of the contracting firm of George B. Spearin, Inc., of New York, died on Jan. 1.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 14-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; annual meeting, New York, N. Y., Jan. 16-18.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; annual convention, Chicago, Ill., Feb. 18-22.

* * *

THE EMPIRE STATE SAND AND GRAVEL PRODUCERS' ASSOCIATION, which held its annual meeting recently in Rochester, is seeking indorsement by New York State of gravel as an alternative for crushed stone in highway construction. The state has accepted gravel which is 90 per cent crushed, but the association is anxious to have it accepted generally. Speakers at the meeting included Henry L. Howe, director of design and construction, city engineering department, Rochester, N. Y., Harry R. Hayes, engineering secretary, New York State Highway Chapter, American Roadbuilders Association, Albany, and others.

WELL DRILLERS' ASSOCIATIONS will hold meetings as follows in the Central States, and these will be of interest to hydraulic engineers, water-works superintendents and officials connected with public water supplies: (1) North Dakota Well Drillers Association, Jan. 23 to 25, Devil's Lake, N. D.; secretary, J. E. Kennedy, Cando, N. D. (2) Minnesota Well Drillers Association, Feb. 6 to 8, Minneapolis, Minn.; secretary, F. H. Klemmenhagen, Renville, Minn. (3) Illinois Well Drillers Association, Feb. 12 and 13, Urbana, Ill.; secretary, S. G. Geiger, Old Colony Building, Chicago. (4) Wisconsin Well Drillers Association, Feb. 18 to 20, Milwaukee, Wis.; secretary, H. A. Butler, Delafield, Wis. (5) Iowa Well Drillers Conference, Feb. 26 and 27, organization meeting at State University, Iowa City, Iowa. Each of these meetings is sponsored by the state geological survey.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK held a meeting Dec. 19, at which Robert H. Jacobs, division engineer in charge of track, the New York City Board of Transportation, delivered an illustrated lecture, "Tracks for Rapid Transit Railroads in New York City." Mr. Jacobs favored track construction of creosoted wooden blocks set in a concrete roadbed as being cleaner, safer and more economical.

THE INDIANA SECTION, American Water Works Association, will hold its annual meeting at Indianapolis, Ind., on Feb. 27 and 28. John W. Moore is president and C. K. Calvert secretary, both of Indianapolis.

THE ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA will hold its annual meeting and election of officers at Pittsburgh, Pa., Jan. 22.

European Briefs

THE GERMAN GENERAL ELECTRIC COMPANY (AEG of Berlin) is negotiating with the Otto Wolff concern regarding the delivery of a large quantity of electrical equipment, building material and machinery worth about 75,000,000 marks, which will be used for railway construction, tramways, public buildings and general construction. The AEG itself will execute the largest part of the construction. The cost will be credited to the government for ten years, to be payable in ten installments with 8 per cent interest. British and German bankers are supporting this scheme.

CONSTRUCTION OF A PIPE LINE from the Galizean (Polish Austrian) oil fields to Danzig or Gdingen is now under consideration. Poland cannot consume the oil she produces, but has to export about 60 per cent of the production, chiefly to Scandinavia. The pipe line would greatly reduce the costs, and British and Polish bankers are said to show lively interest in this project. The order for the 350-mile line would be placed with an American engineering firm, as it is said the Americans have a great experience with oil pipe lines. Pipes would be supplied by the upper Silesian industries.

THE ELECTROWERKE AB, proprietor of the big electric power plants Tschornewitz, Lauta and Trattendorf, which supply electric current to Berlin, the railways, a large part of the Saxonian and central German industries, is now greatly increasing the capacity of the works of Golpa Tschornewitz so that these works will be able to produce next year 1,120,000 hp. All the three plants are based on cheap supply of brown coal.

ELECTRIFICATION is making further progress on German railways. By the end of 1927 a total of 590 km. were electrified. Since then new lines have been opened, so that now 710 km. are electrified. The program for electrification provides for 200 km. of track to be electrified annually for the next twelve years. The electric lines are principally in Silesia, Bavaria, central Germany and Baden.

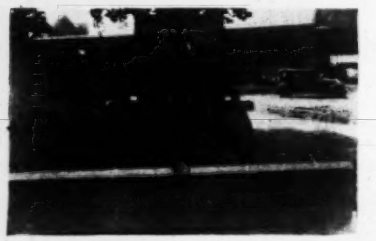
CONSTRUCTION OF THE COLUMBIAN RAILWAY Inbagué-Armenia connecting Bogotà and Buenaventura has been awarded to the French Company Société de Constructiones des Batignolles Paris. Seventeen companies were bidding, but the French offer was the lowest. Work will be started and will be completed within eighteen months. The line will be about 100 miles long and will cost approximately $8,000,000.

THE LARGEST EUROPEAN STEEL BRIDGE, 12 km. long, near Pancevo across the Danube in Yugoslavia, which is being constructed by the Siemens Bauunion, will be finished by the end of this year.

Construction Equipment and Materials

Snow Plow Blade Raised and Lowered by Compressed Air

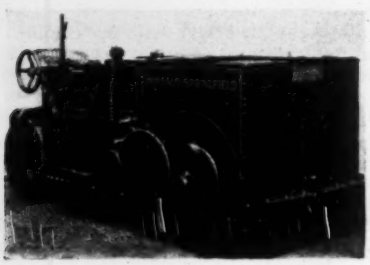
One-man operation of trucks and buses equipped with snow plows is made possible by a pneumatic device for raising and lowering the blade perfected by the Good Roads Machinery Company, Kennett Square, Pa., in collaboration with the Westinghouse Air Brake Company and the White Motor Truck Company. The device is operated by



the regular driver of the truck or bus by means of an air valve and latch rope without distracting his attention from his usual duties. A vertical Westinghouse air cylinder is attached to the "A" frame clamped to the chassis in front of the radiator. This is substituted for the hand-operated hoist usually used. The lift chain is automatically locked when the air is shut off, but can be quickly released by pulling the trip rope. Air is supplied from the brake system of trucks equipped with air brakes; otherwise it is necessary to install a Westinghouse air compressor attached to the timing gear box of the motor.

New Heavy-Duty Motor Roller of 2½-Ton Capacity

A 2½-ton tandem roller driven by a heavy-duty motor is now being produced by the Buffalo-Springfield Roller Company, Springfield, Ohio. Power is furnished by a heavy-duty, four-cylinder, four-cycle motor with cylinders 3½ x4½ in. This is lubricated by a geared force pump and cooled by means of a radiator and fan. Steel driving gears are used, controlled by a friction clutch in the flywheel of the motor. The direction of motion is regulated by shifting gears with a hand lever, while clutch and brake are operated by foot pedals. The rollers are in two sections, the front forming a continuous drum with a 32-in. face, 26 in. in diameter; the rear, or driving, roll 34 in. in diameter with a 40-in. face. The main frame of the machine is made of 5-in. steel channels weighing 11½ lb. per foot.



New Type Excavator Uses Four Bucket Lines

Four booms and bucket lines, mounted in two units of two each, are used in the new bucket excavator recently announced by the Barber-Greene Company, Aurora, Ill. Accuracy in digging is a feature of the machine, which is so designed that it will cut to any depth from 1 in. to 7 ft. and will excavate to a maximum width of 8 ft. 5 in. As the material is dug by a constant milling action, it is broken up fine, ready for immediate use in fill.

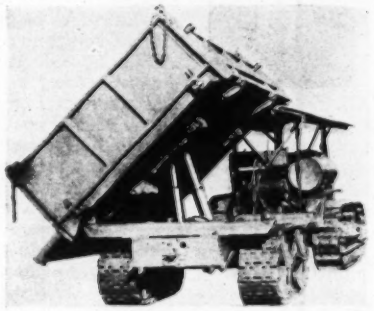
The efficiency of the machine does not depend upon the alertness or ability

of the operator, who does not need to watch the digging operation constantly. His principal occupation is releasing the clutch at the end of each load and letting it back at the start of the next. He also watches a set of indicators showing the angle of the boom and the machine in both horizontal and vertical planes. These dials show the depth of the cut and relation of the two boom units to each other. The digging angle and depth of the whole boom mechanism is adjusted by power.

Three-Way Dump Trailer for Use in Soft Ground

A crawler-mounted dump trailer wagon which will discharge to either side or the rear is the latest addition to the models built by the Athey Truss Wheel Company, Chicago, Ill., designed for use with tractors. These are available in two sizes, 10 and 15 tons, with capacities of 4 to 5 and 7 to 8 cu.yd. The bodies used are the "Commercial" three-way dump bodies described in *Engineering News-Record*, Nov. 22, 1928, p. 788. With loading heights of 62 and 75 in. respectively, the trailers are well adapted to use with elevating graders. The operator at the tractor controls the dumping mechanism without leaving his seat. It is so arranged that a number of trailers may be formed into a train. Westinghouse air brake equipment is available as optional equipment.

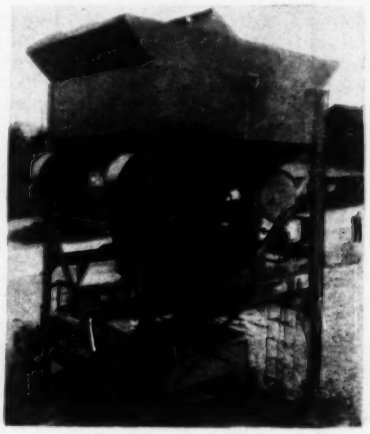
The bodies are mounted on the standard Athey truss wheel, a tracklaying wheel specially designed for use in soft ground. The 10-ton model has a bearing area of 9 sq.ft.; on the 15-ton



model, the area is 12 sq.ft. The body is constructed of heavy gage steel, electrically welded. It is mounted on the chassis by two heavy U-shaped cross-members. The side gates fold down, so that loads discharged from the sides are carried clear of the wheels and track. Doors close automatically when the body is righted. Dumping power is secured from the power takeoff of the tractor, which is attached to a Commercial hydraulic pump by a clutch running in oil. The pump runs only during the dumping operation.

Springless Scale Applied to Proportioning Plant

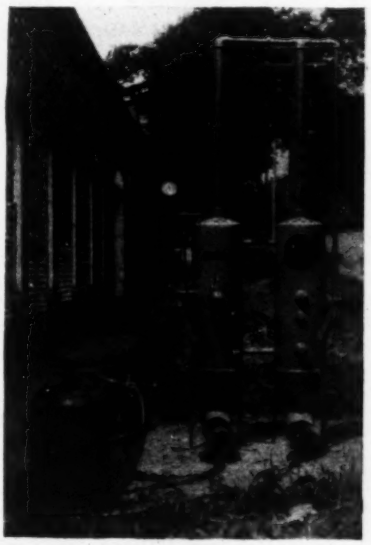
Use of a springless scale to proportion aggregates for concrete results in a number of advantages, according to the manufacturer, the Heltzel Steel Form & Iron Company, Warren, Ohio. This feature is incorporated into a new Agrabatcher, rectangular in form, with hopper bottoms in two compartments with capacities of 3,000 lb. (approximately 31 cu.ft.) of stone and 2,000 lb. (approximately 20 cu.ft.) of sand. The



scale used has a 36-in. dial graduated to 5,000 lb., using 5-lb. graduations. This is equipped with pointers which can be set to any desired position on the rim. In use, the pointers are set at the weight of the sand and stone, and a third pointer is set at the weight of the combined batch. The operator may then weigh either sand or stone separately, or he may weigh either sand or stone first, and then bring the total to the required amount. No counterweights are used.

Lightweight Tank Car Heater

Designed especially for easy transportation, a new tank car heater now being manufactured by E. D. Etnyre & Company, Inc., Oregon, Ill., can be mounted on a two-wheeled trailer for transportation behind a truck or automobile. The total weight of such an outfit is less than 800 lb. It can be set up and hooked to a tank car by one man in a few minutes. Heat is supplied by two oil burners of the generating type, which are furnished with the heater. It is claimed that 125 lb. of steam pressure can be obtained half an hour after the time the heater arrives



at the tank car and that the machine has reduced 10,000 gal. of 150 penetration asphalt in a tank car equipped with double steam coils to a pumping consistency in seven hours, using 32 gal. of kerosene and 25 gal. of water.

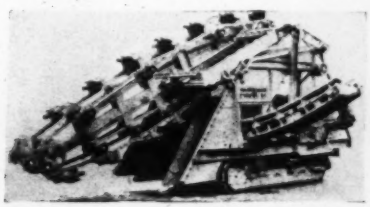
Spreader Operates as Trailer

Even distribution of material along the surface of a highway is accomplished by a trailer-type mechanical spreader built by Highway Service, Inc., New Bedford, Mass., and known as "Handy Sandy." This unit, when towed behind a truck, will apply a uniform application of wet or dry sand, calcium chloride, salt, lime or stone of usual sizes. This is accomplished by means of a distributing roll which revolves with the wheel, against which is fitted an adjustable steel wire brush for regulating the depth of spread. There is sufficient spring in the regulat-

ing brush to allow large stones to pass the roller without affecting the normal spread of finer material. It is claimed that this device will spread a cubic yard of sand 66 in. wide and 1,500 ft. long. The "Handy Sandy" is similar to but of much smaller size than the company's "Big Sandy" introduced last year.

Trenching Machine Built in Larger Size

Greater capacity is the feature of a trenching machine recently announced by the Parsons Company, Newton,



Iowa. Ditches from 18 to 48 in. wide and in depths up to 12 ft. are within its range. The ditch may be dug at any point across the front of the machine or with offset boom in close quarters. The general design is similar to previous Parsons models, with all gears inclosed in oil-tight cases and mounted on shafts fitted with roller and ball bearings.

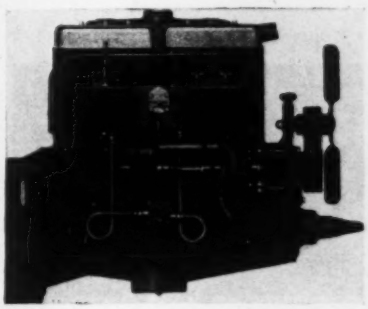
Bucket Loader Adapted to Excavating Work

Designed for making shallow excavations without the necessity for preliminary plowing and scarifying, a new excavator and road grader recently an-

nounced by the George Haiss Manufacturing Company, Inc., New York City, is especially commended for highway work. The machine has the general appearance of a bucket loader but is heavier in construction to stand the harder work. Buckets are provided with individual digging teeth of heavy manganese steel. Manganese steel picks loosen the dirt, which is fed into the bucket by inclined feeding propellers. The effect of these is to cut a path wider than the bucket, permitting the creeper-mounted chassis to run on the finished grade. The makers claim that this machine will make a cut 8 ft. wide and from 12 to 18 in. deep at a crowding speed of 4 ft. per minute, handling stones up to 8 in. in diameter.

Heavy-Duty Motors of New Design in New Series

A completely new series of four-cylinder industrial engines of slow-speed type, designed especially for tractors, shovels, cranes, crushers and other applications where continuous duty is necessary, has been announced by Continental Motors Corporation, Muskegon, Mich. There are eight models, known as H21 to H28, inclusive, developing power from 39 hp. in the smallest to 125 hp. in the largest. All operate at a recommended speed of 1,000 r.p.m. The cylinder bores vary from 5 to 6¼ in., the stroke from 6½ to 7½ in. Many new features are incorporated, such as removable cylinder sleeves, overhead valves, large crankshafts with five main bearings, dry sump oiling system and



built-in governor. The water pump is of the gear-driven, centrifugal type. A triple belt drive is used on the fan. Ignition is by high-tension magneto. Other equipment furnished includes air cleaner and oil filter.

Clamshell Bucket Built for Light Cranes

A number of new features are to be found in a general service ½-cu.yd. clamshell bucket just brought out by the G. H. Williams Company, Erie, Pa. A straight-line closing pull has been given by lining up the sheaves on the power arm, which are in tandem. The sheaves are furnished with either roller or plain bearing, at the option of the user. Extra leverage for hard digging

is secured by an improved corner-bar bracket design, the brackets extending out over the edge of the back plate. The scoop has heavy renewable digging lips which extend up both sides. A special attempt has been made in the design to provide for easy mount-

ing of the counterweights. As a result there is less tendency for the crane to be used with the counterweights in place in light digging where the extra weight is not needed.

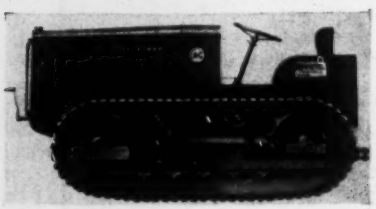
Road Steel Supported by Easily Removed Device

The support of reinforcing steel at the proper distance below the surface of a road, always a troublesome problem to contractors, is secured by the device illustrated, which is being marketed by the Concrete Steel Company, New York

City. Turning a handle at the end of a supporting bar releases the steel after the concrete has been poured, after which the device is easily withdrawn by lifting straight up.

Crawler Tractor in Smaller Size

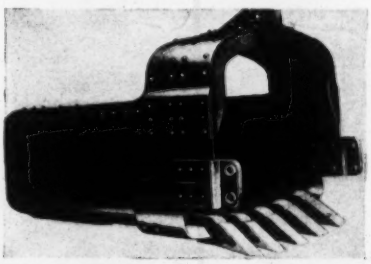
A lighter addition to the series of Monarch tractors has been announced by the Allis-Chalmers Manufacturing



Company, Milwaukee, Wis. The new model, known as the Monarch 35, develops 36 hp. The track is of extra length, giving 71½ in. of ground contact. Power is provided by a four-cylinder motor of Allis-Chalmers make, 4¾-in. bore, 6½-in. stroke, with removable sleeve cylinders. This attains a maximum speed of 930 r.p.m. and is under governor control. Ignition is by high-tension magneto with impulse starter. Cooling is provided by an impeller pump, a fan and a 10-gal. radiator. Electric starting and lighting equipment is furnished if desired.

Cableway Bucket Suitable for Light and Heavy Digging

The use of two buckets with a cable digging machine to care for different classes of excavation is eliminated by the design of a new Universal bucket now being produced by Sauerman Brothers, Inc., Chicago, Ill. On work for which a light-duty bucket was formerly furnished, the new model is used without teeth; with the addition of teeth, it handles work formerly requiring a heavy-duty bucket. The bucket



uses an extra-heavy manganese steel lip and a reinforced heavy bail. Runner shoes, which are replaceable, protect the bottom from wear. All corners are rounded to permit easier penetration in digging and cleaner and quicker release in dumping.

Truck Available With Three-Way Dump Body

A 3-ton truck on a 135-in. wheelbase chassis is now being produced by the Dodge Brothers Corporation, Detroit, Mich. This may be obtained equipped with a three-way dump body produced by the Differential Steel Car Company,

Findlay, Ohio. In this body the down-folding side doors operate automatically, lowering as the body dumps and throwing material well clear of the wheels. The doors close automatically when the body is brought back to the usual position. The hoisting units used consist of a triple telescoping lift with ball-and-socket joints, permitting a rocking motion in any direction. The truck has a six-cylinder motor four-speed transmission, and is equipped with four-wheel brakes of the internal-expanding hydraulic type. A variety of wheel and tire equipment is available for different conditions. Standard equipment includes gasoline and oil filters, air cleaner, radiator shutters, water-temperature indicator and thermostat.

New Publications

Shovels—MARION STEAM SHOVEL COMPANY, Marion, Ohio, has issued four catalogs descriptive of its models recently announced. Bulletins 334, 335 and 336 are devoted to the new Type 480 2-cu.yd. shovel, dealing with electric rheostatic control, Ward-Leonard control and steam operation, respectively. The fourth bulletin, 337, covers the Type 450 1½-cu.yd. gas-electric machine. Each bulletin contains a complete discussion of the design and construction of the model to which it refers, together with clearance diagrams and dimension tables.

Foundation Equipment—UNION IRON WORKS, INC., Hoboken, N. J., is distributing a handsomely illustrated 112-p. catalog which describes piledrivers and leads, boilers and hoists, air locks, buckets and similar equipment for foundation work. Besides detailed descriptions of the apparatus produced by the company, the book devotes many pages to illustrations of typical piledriving installations and contains articles on the bearing power of piles, subaqueous work, the history of piledriving and compressed air in foundation work, and the use of the water jet.

Winter Construction Tools—AEROIL BURNER COMPANY, INC., West New York, N. J., in Bulletin 72 describes equipment for heating, thawing, melting ice and snow removal, including concrete heaters, torches, salamanders, water heaters and car-thawing outfits.

Electric Motor Drives — ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., discusses the Texrope drive for industrial machinery in Bulletin 1228-H.

Manufacturers and Trade Associations

CALENDAR

Annual Meetings

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 9-11.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C., annual convention, Cleveland, Ohio, Jan. 14-18.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 21-24.

The Business Side of Construction

Seasonal Low Demand for Construction Materials

The movement of cement, lime, plaster, clay products, aggregates and other masons' materials is seasonally slow as regards both wholesale transactions and shipment from dealers' yards. January, however, is normally the month in which the low point of trade volume is reached in the building materials market. Common brick will likely be the first of the basic materials to show a hardening of prices during the first quarter of the new year. This possibility lies in a continuation of the present volume of demand, accompanied by obstruction of water-borne shipments due to ice.

Whatever weakness exists in brick prices in the current market is entirely on the side of dealer transaction. As an illustration of this, the brick situation at New York is brought to mind. Here the price of first-quality Hudson River common brick has been $13@$14 per thousand wholesale for several months. Dealers, on the other hand, are asking $16@$17 per thousand, delivered at site of job, and are at the same time cutting under to a price as low as $14@$15, or but $1 above the wholesale cost. Competition among dealers in face brick, hollow tile and cement is also very keen, with price cutting reported.

Metal lath prices continue nominal, with widespread weakness. This is considered singular in view of the recent $4 per ton advance in sheet stock from which the lath is manufactured.

Wire nails have advanced 10c. per keg, Pittsburgh mills. Prices of other steel products, together with iron and non-ferrous metals except tin, are steady, with upward tendencies foreseen in the attitude of sellers. Linseed oil, white lead and other paint materials, on the contrary, show declining trends.

Lumber demand is experiencing the usual dullness characteristic of the period of the year in which inventories are taken at retailers' yards. Offsetting, in a measure, this slackness of buying among retailers is a comparatively active current demand for hardwood used in automobile manufacturing, fir for railway car construction and hemlock boards and dimension stock used in buildings.

Despite systematic curtailment of production at mills in general, surplus stocks are reported as existing at points on either coast. In the Central States, however, mill and yard stocks of seasoned lumber are unusually low, particularly in hemlock. Pine lumber production, orders and stocks are at comparatively low levels. On the whole, the lumber industry will probably enter 1929 with three billion feet less lumber on hand than was available on Jan. 1, 1928.

Since September, 1928, there has been a gradual month-to-month decline in demand for fabricated structural steel. This, in the opinion of the American Institute of Steel Construction, has been due to the continuation of high money rates and increased cost of new investment money. The Institute is informed through its membership that bridge building is expected to become especially active during 1929. Also during the year a much larger business is expected incident to the construction of hangars for the numerous airports throughout the country.

The average cement price for the nation sustained a net decline of 1.9 per cent in the twelve months of 1928.

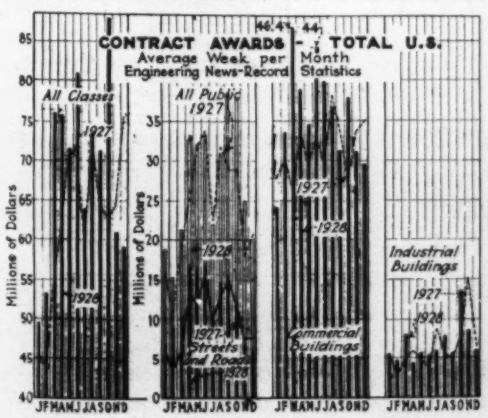
10 Per Cent Increase in Annual Construction

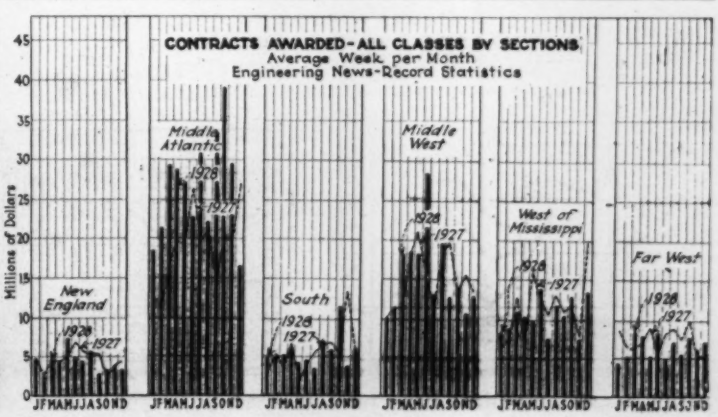
According to data collected throughout the year by *Engineering News-Record*, the net volume of contracts awarded during 1928 was $3,578,585,000, an incerase of 10 per cent over that reported for 1927. This is several per cent under the estimates made a few weeks ago, the drop being due to the elimination of several large duplications in reports. The greatest increase in annual volume of contracts awarded was recorded for commercial buildings, the value of these projects during 1928 exceeding the 1927 volume by about $227,000,000. Other increases were recorded by the water-works group, increasing by about $46,000,000, industrial buildings

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, DECEMBER, 1928
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Dec. 1928	United States Year 1928	Canada
Water-works	$230	$5,369	$14	$794	$1,305	$257	$7,969	99,442	$1,512
Sewers	250	305	632	2,292	1,371	1,246	6,096	100,732	3,772
Bridges	25	2,460	4,613	1,410	2,066	77	10,561	130,203	7,795
Excavations, drainage, etc.	.....	.....	.....	178	4,530	58	4,766	37,734	6,432
Streets and roads	235	4,532	2,539	2,942	8,632	4,271	23,151	615,279	23,158
Industrial buildings	2,967	6,417	1,246	10,236	2,377	1,672	24,915	355,187	27,750
Commercial buildings	9,020	42,815	5,082	22,750	18,143	20,462	118,272	1,859,418	66,999
Federal government	341	1,994	523	256	354	22	3,490	69,815	.....
Unclassified	205	2,748	9,402	10,352	14,772	308	37,787	310,775	38,146
December, 1928*	13,273	66,640	24,051	$1,210	53,550	28,373	237,097	.....	.....
November, 1928†	19,947	147,593	17,984	53,751	36,245	30,509	306,029	.....	.....
December, 1927†	21,650	134,125	30,049	66,727	99,950	25,343	377,844	.....	.....
Total year 1928	222,242	1,383,111	290,525	809,463	537,733	335,511	.....	3,578,585	175,564
Total year 1927	234,274	988,994	290,465	775,955	593,417	370,661	.....	3,253,766	180,763

*Four weeks. †Five weeks.





about $68,000,000, streets and roads about $90,000,000, and federal government projects with an increase of about $19,000,000 over 1927. On the other hand, several construction groups recorded material drops under 1927 totals. The 1928 awards for sewers decreased by about $8,000,000, bridges by about $13,000,000, excavations by about $4,300,000, and the miscellaneous group total dropped almost $57,000,000.

The major portion of the material increase over 1927 was confined to the communities in the Middle Atlantic States. This section reported an increase of about $395,000,000 in the volume of construction projects during 1928 as compared with 1927. The Mid-Western section recorded an increase of about $33,000,000 over 1927. Construction in the South was almost the same as during 1927. Other sections, however, reported decreases in the total annual volume of contracts awarded. The New England volume dropped about $12,000,000, the territory immediately west of the Mississippi $44,000,000, and the Far West reported a drop of about $35,000,000.

Labor Conditions in Construction Industry Generally Satisfactory

Reports received by *Engineering News-Record* from representative cities in the seven great geographical divisions in the United States show greater activity in construction than was in evidence at this time in 1927. Contract figures appearing on a preceding page show the degree of gain in 1928. This increase is accentuated by the fact that construction cost (labor plus materials) has advanced but 0.2 per cent in the last year.

About the same number of labor disputes exist now as did a year ago. The tendency, however, is more toward jurisdictional disputes than toward wage demands or even the five-day week.

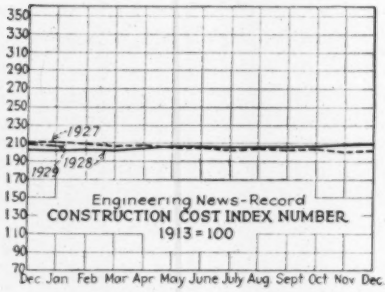
Typical of the strike situation is the walkout of ironworkers and laborers in Newark, together with the strike of electricians at Spokane this year, as compared with the strike of cement finishers and waterproofers which began in Boston about a year ago. The dispute between the Newark laborers and ironworkers is over carrying of metal forms. The Spokane electricians demand an advance of $1 per day, to $9.

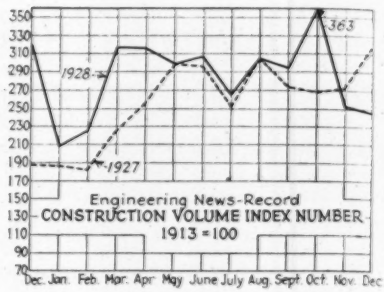
Local conditions in certain of the major cities are as follows:

In Birmingham at the present time there is an oversupply of both skilled and common laborers. The constant influx of all classes of labor from many near and distant cities is the cause of much of the present unemployment in that city. The indications are that the year 1929 will be one of the most prosperous that this section has ever had. Contracts will soon be let for a number of large manufacturing plants and other buildings in the district, totaling approximately $27,000,000. A number of the local steel and iron plants have orders booked well into the second quarter of 1929. Contractors, builders and supply men are anticipating a better year in 1929 than in 1928.

The Minneapolis employment situation is also good. Large construction projects now under way offer employment to all skilled trades. Common laborers are in fair demand, and this is taken as evidence that more building is going on at present than is usual for this time of year. There are also no labor troubles of any kind in this district.

In St. Louis most of the unemploy-



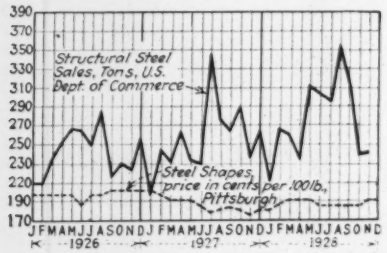


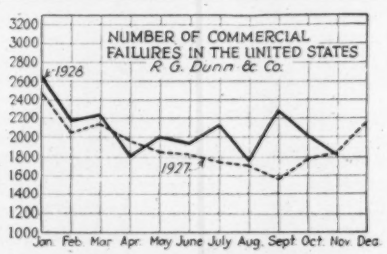
ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

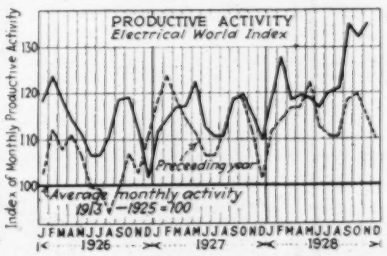
Construction Cost and Volume Index Numbers

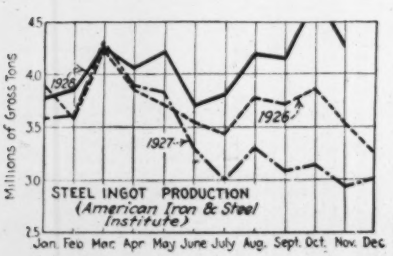
E.N.-R. Cost		E.N.-R. Volume*	
Jan. 1929	**209.40**	**Dec. 1928**	**244**
Dec., 1928	210.16	Nov. 1928	251
Jan., 1928	203.90	Dec., 1927	319
Peak June, 1920	273.80	1928 (average)	287
1928 (average)	276.78	1927 (average)	263
	1913 (average)..... 100.00		
1927		**1927**	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319
1928		**1928**	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299
June	206.15	June	308
July	206.65	July	266
August	207.29	August	306
September	207.29	September	296
October	207.71	October	363
November	209.46	November	251
December	210.16	December	244

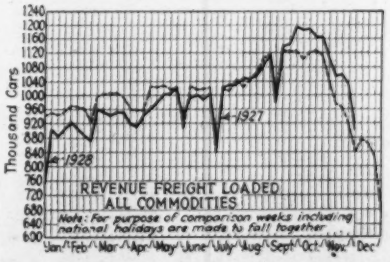
*Corrected for price changes.

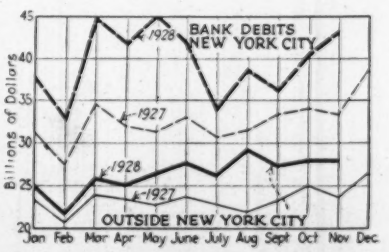

Structural Steel Sales, Tons, U.S. Dept. of Commerce
Steel Shapes, price in cents per 100 lb., Pittsburgh
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928




PRODUCTIVE ACTIVITY
Electrical World Index
Index of Monthly Productive Activity
Preceding year
Average monthly activity 1913 + 1925 = 100
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928




Thousand Cars
1927
1928
REVENUE FREIGHT LOADED
ALL COMMODITIES
Note: For purpose of comparison weeks including national holidays are made to fall together
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.



STEEL SALES —BUSINESS FAILURES—ELECTRICAL ENERGY CONSUMED—CAR LOADINGS—CHECK TRANSACTIONS

CURRENT BUILDING TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.25@1.40	$0.60@0.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62½	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	.....	1.75	.25@.40
Boston	1.50	1.35½	1.37½	.85	1.27½	1.37½	.45@.80
Cincinnati	1.50	1.37½	1.37½	.92½	1.37½	1.37½	.45@.60
Chicago	1.62½	1.10@1.50	1.00@1.50	.90@.96¼	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.67½	1.12½	1.25	.35@.75	1.25	1.25	.35
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.37½@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.35@.75
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.45@.60
Montreal	1.25	.85	.75	.45	.50	1.00@1.10	.35@.40
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.75
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.40@.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.37½	1.12½	1.00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.50	1.12½	1.25	1.00	1.12½	1.25	.70

ment in the building trades is seasonal. Prospects are bright for the first quarter of 1929 in all trades and vocations, there having been a slight improvement recently in employment in the basic industries aside from building. Many large industrial plants have definitely planned to increase the number of workers during the present quarter.

Cleveland builders predict a better year in 1929 than in 1928. These expectations are based on the passage of various bond issues and also on the volume of plans now in architects' hands.

There is apparently a negligible amount of unemployment among building trades mechanics in New York City, judging from the attitude of the unions toward higher wages and shorter hours for 1929. The bricklayers are expected to be the first to take action in the demands for a five-day week with a 10 per cent wage increase.

Chicago, on the other hand, differs from the foregoing cities in that in this locality many mechanics are being laid off, with slight chance of regular reemployment until spring. There is keen competition for jobs among the contractors, seventeen having bid on a bridge substructure for the Sanitary District of Chicago.

Dallas reports a great surplus of all types of labor due to migration from the North and also owing to the natural surplus left over after the completion of the harvest season. Construction is reported as being particularly slow.

In Detroit there is a seasonal decline in construction accompanied by a reduction in the number of employed workers in all industries, as compared with last month.

Unemployment is on the increase in Philadelphia, with wage cutting prevalent. There is also a tendency toward increase in the number of jurisdictional disputes of minor importance among the building trades.

The average skilled building trade wage rate for the country is $1.35 per hour, against $1.35¼ in December and $1.33⅜ for January, 1928. Common laborers receive an average rate of 55.9c. per hour, compared with 56.28c. in December and 55c. for January, 1928.

Schwab's Ten Rules for Continued Prosperity

Charles M. Schwab, chairman of the Bethlehem Steel Corporation, believes that American business has entered a new era, an era full of new problems, but an era of continued prosperity if a few fundamental considerations are kept in mind.

Mr. Schwab enunciates the following ten rules as the key to lasting prosperity:

Pay labor the highest possible wages. Prosperity is intimately related to a liberal wage scale.

Treat labor as a business partner. Successful industry depends more on human relations than upon the organization of money and machines.

Conduct business in the full light of day. Public confidence and public suspicion may be separated only by a door.

Remember that the law of supply and demand is inexorable. It would also be well to remember that there is no necessity for producing an excess.

Live and help live. Even prosperous industries cannot afford to have the backward industries too far behind the procession; prosperity to be permanent must be equally distributed.

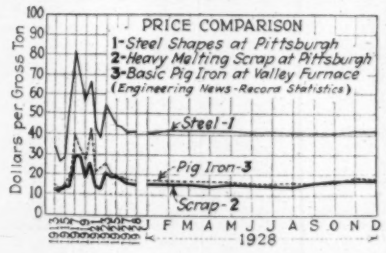
Welcome new ideas. To establish permanent institutions we must always be prepared for change.

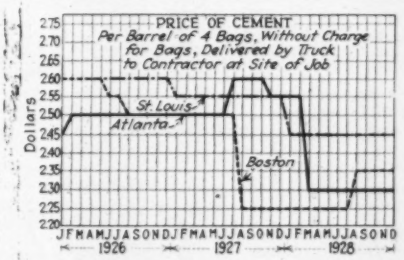
Never be satisfied that what has been achieved is sufficient. Smugness and complacency do not promote progress.

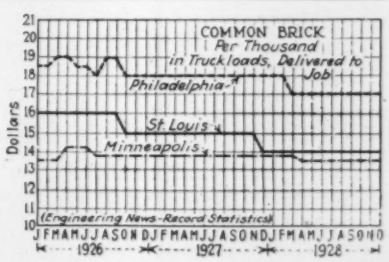
Operate business on the most economical basis. Price cutting, overexpansion, uneconomical methods of distribution are just as harmful to business and to the public as price fixing, monopolies and rebates.

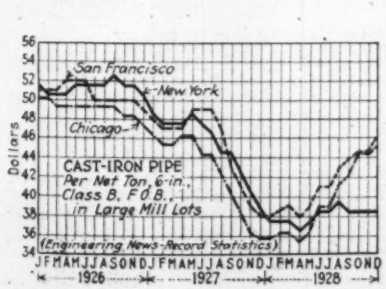
Look ahead and think ahead. It is easier to avoid depressions than it is to cure them.

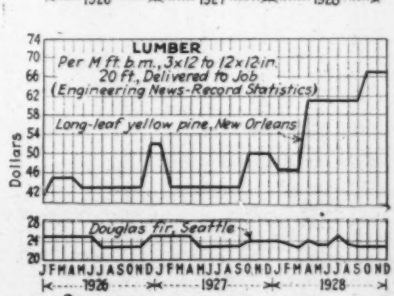
Smile, be cheerful, and work upon the basis that the fundamental purpose of business is to promote the happiness of human beings.

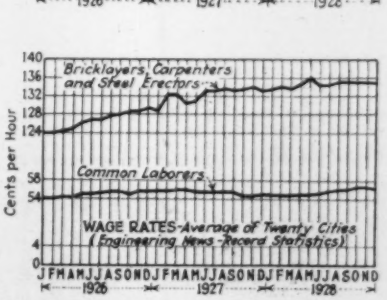












PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per bbl., quoted by manufacturers and dealers, delivered to contractors, in carloads, *without charge for bags*. Cash discount not deducted.

	Jan. 3, 1929	One Month Ago	One Year Ago
Atlanta	$2.10	$2.10	$2.45
Baltimore	2.65	2.65	2.50
Birmingham	2.60	2.60	2.40
Boston	2.45	2.35	2.05f.o.b.
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Chicago (f. o. b.)	2.05	2.05	2.05
Cincinnati (f. o. b.)	2.22	2.22	2.23
Cleveland (f. o. b.)	2.24	2.24	2.24
Dallas	2.15	2.15	2.05f.o.b.
Davenport (f. o. b.)	2.24	2.24	2.24
Denver	2.55	2.55	2.85
Detroit (f. o. b.)	1.95	1.95	2.00
Duluth (f. o. b.)	2.04	2.04	2.04
Indianapolis, (f. o. b.)	*2.09*	2.19	2.19
Jersey City	2.35	2.35	2.13f.o.b.
Kansas City, Mo.	2.20	2.20	2.07f.o.b.
Los Angeles	2.66	2.66	2.50
Milwaukee (f. o. b.)	2.20	2.20	2.20
Minneapolis (f. o. b.)	2.22	2.22	2.22
Montreal (f. o. b.)	1.41	1.41	1.41
New Orleans	2.35	2.35	2.07f.o.b.
New York	2.25@2.35	2.25@2.35	2.25@2.35
Peoria (f. o. b.)	2.22	2.22	2.22
Philadelphia	2.40	2.41	2.40
Pittsburgh (f. o. b.)	2.04	2.04	2.04
St. Louis	2.45	2.45	2.05f.o.b.
St. Paul (f. o. b.)	2.22	2.22	2.22
San Francisco	2.41	2.41	2.51
Seattle	2.70	2.70	2.65
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Leeds, Ala.	$1.65
Buffington, Ind.	1.80	Lehigh Valley District	1.75
Clinchfield, Ga.	1.65	Mason City, Ia.	1.80
Fordwick, Va.	2.05	Mitchell, Ind.	1.90
Hannibal, Mo.	1.90	North Birmingham, Ala.	1.45
Hudson, N. Y.	1.75	Richard City, Tenn.	1.85
Iola, Kan.	1.85	Steelton, Minn.	1.85
Kingsport, Tenn.	2.05	Universal, Pa.	1.80
La Salle, Ill.	1.90	Wyandotte, Mich.	1.70

SAND AND GRAVEL—Dealers' quotations per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds.

	Gravel 1½ In.	Gravel ¾ In.	Sand
Atlanta, per ton	$3.50	$3.50	$2.50
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb.)	3.00	3.00	2.65
Boston, per ton	2.00	2.00	1.50
Chicago	**2.25**	**2.25**	**2.25**
Cincinnati, per ton	1.90	1.90	1.60
Cleveland	2.70	2.70	2.50
Dallas	2.50	2.50	*2.00*@3.00
Denver (2,700 lb.)	1.80	1.80	1.30
Detroit (2,600 lb.)	3.00	3.00	2.50
Kansas City, Mo.	2.40	2.40	.....
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.)	2.25 ton	2.25 ton	1.00
Montreal, per ton	1.90	1.50	1.20
New Orleans (2,700 lb.) (2,500 lb.)	3.00	3.00	2.00
New York	3.25@3.50	3.25@3.50	2.00@2.25
Philadelphia, per ton	**2.30@3.15**	**2.30@3.15**	**1.50@2.31**
Pittsburgh, per ton	2.40	2.40	2.60
St. Louis, per ton	**2.20**	**2.00**	1.60@1.90
San Francisco (2,800 lb.)	*1.75*	*1.75*	**1.50**
Seattle (3,200 lb.) (2,850 lb.)	2.00	2.00	2.00

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Dealers' quotations per cu.yd., delivered. Weight, 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$3.50	$3.50
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.40	2.40
Chicago, Limestone	**2.25**	**2.25**
Cincinnati, per ton	2.50	2.50
Cleveland, per ton	3.00	3.00
Dallas	3.25	3.40
Denver, Granite (2,700 lb.)	2.50	2.50
Detroit, Limestone, per ton	2.50	2.60
Kansas City, Limestone, (2,450 lb.)	2.00	2.00
Los Angeles per ton	2.15	2.15
Minneapo. Limestone, per ton	2.25	2.25
Montreal, per ton	2.10	2.10
New York, Limestone	3.25@3.50	3.25@3.50
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton (2400 lb. per cu.yd.)	1.90	1.90
San Francisco, Trap rock (2,400 lb.)	*1.65*	*1.65*
Seattle, (2,700 lb.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.25	$2.05	$0.80
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Dealers' quotations on hollow building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.072	*$0.10*	*$0.136*	*$0.163*	*$0.181*
Baltimore	.095	.....	.175	.....	.232
Birmingham	.09	.127	.174	.218	.261
Boston	.08	.105	.145	.185	.25
Chicago	.076	.104	.142	.182	.202
Cincinnati	.074	.105	.136	.175	.202
Cleveland	.064	.088	.128	.171	.19
Dallas	.096	.1205	.1785	.251	.284
Denver	.0975	.135	.175	.2125	.25
Detroit	.096	.132	.18	.256	.293
Kansas City	.06	.....	.158	.....	.25
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0675	.0845	.131	.134	.189
Montreal	.12	.....	.22	.....	.315
New Orleans	.09	.125	.162	.22	.245
New York	.0864	.1296	.162	.....	.....
Perth Amboy, N.J.(f.o.b.)	.....	.....	.....	.252	.312
Philadelphia	.11	.145	.22	.27	.34
Pittsburgh	.068	.....	.1175	.....	.1726
St. Louis	.078	.105	.145	.175	.21
San Francisco	.108	.156	.255	.....	.....
Seattle	.08	.11	.18	.....	.....

BRICK—Dealers' quotations, delivered, per thousand are as follows:

	Common	Paving 3x8½x4-in.	Paving 3½x8½x4-in.
Atlanta	$14.75	$38.00*	$45.00†
Baltimore	15.00	40.00	45.00
Birmingham	15.00	32.00*	36.00†
Boston	17.25	45.00	50.00
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	13.50	35.00	.....
Denver, salmon	12.00	.....	.....
Detroit	15.50	35.50	38.50
Kansas City	14.00	.....	.....
Los Angeles	11.00	.....	.....
Minneapolis	13.50	.....	.....
Montreal	20.33	.....	.....
New Orleans	16.00	40.00*	50.50
New York	16@19	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	.....	.....
St. Louis, salmon	13.00	40.00	45.00
San Francisco	**14.50**	.....	.....
Seattle	14.00	50.00	55.00

*2½x8½x4 in. †3x8½x4.

LIME—Dealers' quotations, delivered to job:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
Atlanta	$27.50	$17.50	$2.30†	$2.10†
Baltimore	20.00	14.00	2.55†	.....
Birmingham	22.00	16.00	3.00†	2.00†
Boston	21.00	14.50	3.80*	2.90*
Chicago	20.00	18.00	20.00‡	1.50†
Cincinnati	18.00	13.20	.....	13.20‡
Cleveland	20.00	16.00	2.50†	2.50†
Dallas	*19.00*	.....	.....	*17.50‡*
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	24.00	13.00	2.75†	2.50†
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	21.00	21.00	.....	15.00‡
New Orleans	.....	.....	2.60	1.40†
New York	21.00@22.00	14.00@15.00	4.00@4.10*	3.15@3.25*
Philadelphia	22.00	15.00	.....	.....
Pittsburgh	21.00	19.00	18.00‡	17.00‡
St. Louis	**24.00**	**18.00**	**2.75†**	2.10*
San Francisco	27.50	20.00	.....	1.70†
Seattle, paper sacks	36.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@.20	Minneapolis, f.o.b.	$0.12
Brooklyn and Queens	15@.17	New Orleans	.22
Cleveland	.17@.18	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Slab work, f.o.b. cars, at mill, Bangor, Pa., per sq.ft.:

Thickness	1 to 10 Sq.Ft.	10 to 16 Sq.Ft.	16 to 22 Sq.Ft.	22 to 28 Sq.Ft.	28 to 35 Sq.Ft.	35 to 40 Sq.Ft.
1-in.	$0.30	$0.36	$0.44	$0.52	$0.62	$0.77
2-in.	.50	.60	.68	.76	.86	1.01

Road and Paving Materials

PAVING STONE—Dealers' quotations, f.o.b., in carloads or in cargo lots, for granite blocks, 4x8x4-in., dressed:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.50 per sq.yd.
Minneapolis, Sandstone	2.74 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.75 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd.	150.00 per M.
Philadelphia	125.00 per M.
St. Louis	3.30@3.40 per sq.yd.
San Francisco, Basalt block, 4x7x8	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Dealers' quotations, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.40
Chicago	3½	16	2.10
Cincinnati	3½	16	2.35
Dallas	4	18	3.90
Kansas City	3½	16	3.85
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	2.30
New York	3½	16	2.70
St. Louis	3½	16	2.30

FLAGGING—Dealers' quotations, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBBING—Dealers' quotations: *New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, delivered, 5x16 in., 90c. per lin. ft.; roundings, $1.25 per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	$22.60	$18.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	24.50	18.25
Chicago (Texas)	24.50	21.30
Cincinnati (Kentucky Rock)	.....	11.65
Cleveland	24.50	20.50
Dallas (Texas)	26.00	.....
Denver (California)	35.00	.....
Detroit (Mexican)	24.00	19.00
Kansas City, Mo. (Texas)	27.30	22.30
Los Angeles ("D" Grade, Calfornia, f.o.b. El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	25.00	.....
Minneapolis, (Stanolind, f.o.b. Twin Cities)	29.10	20.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	24.50	16.50
Philadelphia (Mexican)	20.00	18.00
Pittsburgh	26@30	16@18
St. Louis (Mexican)	23.50	19.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, California, f.o.b Richmond refinery)	19.50	13.50

*At refinery.

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	.06
Dallas, 50@60% asphalt	.06
New York, 40@50% asphalt. (at terminal)	.06
New York, 50@60% asphalt. (at terminal)	.06
St. Louis, 40@50% asphalt	.0394
St. Louis, 50@60% asphalt	.0394

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$16.50@$17.00
Pittsburgh, basic, incl. freight ($1.76) from Valley	19.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	3.75	3.75
New York, warehouse, delivered, 250 to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (Dec. 27, 1928)	1.90*	1.90*
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.25	3.25

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.30@3.00
Cleveland, warehouse, delivered	2.25@3.00
Dallas, warehouse, delivered	3.50
New York, warehouse, delivered, 250 to 3,999 lb.	2.85@3.25
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.00
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Dealers' quotations per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$15.00	$19.00	$14.00	$18.00	$21.50	*$16.00*
2.5	16.00	20.00	15.00	19.00	24.00	*17.00*
3.0	17.50	22.50	16.50	21.00	.....	*19.50*
3.4	20.00	24.50	18.00	22.50	30.00	*21.50*

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and dealers' from warehouses in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	40	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	.....
180	78	3.35	3.43	4.73	3.60	3.47	.....

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base sizes:

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$3.80	$4.65
Cleveland, warehouse, delivered	3.25	3.60	4.45
New York, warehouse, delivered	3.90*	4.20	4.95
Pittsburgh, large mill lots, f.o.b.	2.00@2.10	2.75@2.85	3.50@3.60
St. Louis, warehouse, delivered	3.45	4.10	4.95
San Francisco, warehouse, delivered	*3.35*	*3.80*	5.40

*250 to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
Special steel round strand rope	30%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations per 100 lb., ½-in., full packages:

	Structural	Boiler
Chicago, warehouse, delivered	$3.60	$3.60
Dallas, warehouse, delivered	*4.50*	*4.50*
New York, warehouse, delivered	5.00	5.00
Pittsburgh, large mill lots, f.o.b.	2.90	2.90
St. Louis, warehouse, delivered	3.75	3.75
San Francisco, warehouse, delivered	5.75	5.75
Seattle, warehouse, delivered	3.75	3.75

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill, per package $11.20

SHIP SPIKES—Dealers' quotations per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	*$5.55*	*$5.10*	*$4.95*
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Dealers' quotations per 100 lb. keg, delivered from warehouse stocks, also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.55@$2.65	$3.30	$3.10	$3.05	$3.75	$3.35	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$12.25@$12.75	$14.75@$15.25	
Stove plate	*8.00@ 8.50*	14.00@ 14.50	$10.50@$11.00*
No. 1 machinery cast	13.00@ 13.50	17.00@ 17.50	*13.00@ 13.50**
Machine shop turnings	7.25@ 7.50	9.00@ 9.50	8.00@ 8.50
Cast borings	6.75@ 7.00	12.00@ 12.50	*9.00@* 9.50
Railroad malleable	10.00@ 10.50	17.00@ 17.50	14.50@ 15.00†
Re-rolling rails	13.00@ 13.50	16.50@ 17.00	13.50
Re-laying rails, 56@60 lb.	23.00@ 24.00	23.00@ 25.00	.....
Heavy melting steel, No. 1	12.00@ 12.50	14.75@ 15.25	*13.50* @14.00
Iron and steel pipe	10.75	11.50@ 12.00	.....

*Net ton. †Automotive.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71*
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15†
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15†		

*Except iron or steel pipe and fittings. †Minimum weight on structurals, 60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mil lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	30@32	34@36	34@36

RAILWAY TIES—Dealers' quotations, f.o.b., for fair-sized orders:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.10	*1.65*
	Red oak, creosoted	1.40	2.05
San Francisco	Sap pine or cypress, untreated	.85	1.20
	Douglas fir, green, untreated	.82	1.14
Montreal	Douglas fir, empty cell, creosoted	1.73	2.32
	Birch or maple, untreated	.75	1.25
	Birch or maple, creosoted	1.25	1.55

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb., f.o.b. Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅜-in. and larger	$2.80	$3.55	$3.50	$3.65@$3.75	$3.85
Track bolts	3.80	4.55	4.50	4.65@ 4.75	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.50	.....	.....

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Cast Iron Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., in large mill lots:

	4-In.	6-In. and Over
Birmingham mill	$41.00	$38.00
Burlington (N. J.) mill	39.00	36.00
Chicago	49.20@$0.20	46.20@47.20
New York	41.60	38.60
Pittsburgh	49.50	46.50
St. Louis	46.60	43.60
San Francisco	51.00	48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Dealers' quotations, delivered, in cents per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.34	$0.75	.....	.....	.....	.....
Baltimore	.16	.24	.46	.....	$1.83	.....	$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.175	.285	.53	1.25	2.05	3.25	5.70
Chicago	.16	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.144	.224	.432	.80	1.44	2.304	4.8175
Cleveland	.18	.28	.54	1.30	2.34	4.68	8.18
Dallas	.256	.42	.792	1.70	3.00	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52	.....	1.90	3.80	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis, cars	.1575	.25	.45	.85	1.80	3.75	4.94
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.195	.325	.5525	.969	1.8525	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.025	1.845	3.60	5.6375
Pittsburgh, factory	.0945	.147	.2835	.90	1.62	3.024	4.8175
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.26	2.16	3.60	.....
Seattle	.22	.30	.54	1.26	2.16	3.60	.....

CLAY DRAIN TILE—Dealers' quotations, delivered, per 1,000 lin.ft.:

Size, In.	New York	Birmingham	St. Louis	Dallas	San Francisco	Seattle
3	$40.00	$45.00	$50.00	.....	.....	$40.00
4	45.00	56.00	50.00	$73.00	$67.50	60.00
5	50.00	80.00	85.00	110.00	86.25	.....
6	78.00	105.00	85.00	118.00	112.50	90.00
8	130.00	175.00	195.00	150.00	187.50	.....

Miscellaneous

LINSEED OIL—Dealers' quotations on raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:
New York....$0.108 Chicago....$0.114 Minneapolis....$0.119

WHITE AND RED LEAD—Dealers' quotations per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.25; Red, dry, $13.25; Red, in oil, $14.75.

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	5.50@ 5.60
Soda ash, 58%, in bags, per 100 lb	1.32@ 1.35
Chlorine, liquid, cylinders, per lb	.05@ .08
Bleaching powder, in drums, f.o.b. works, per 100 lb	2.00@ 2.10

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¼-in., 8-ft.; ⅜-in., 6-ft.; ½-in., 4½-ft.; ¾-in., 3-ft.; 1-in., 2-ft., 10-in.; 1¼ in., 2-ft. 4 in. Following are dealers' quotations per pound for ½-in. and larger, delivered in 1,200-ft. coils:

Atlanta	$0.25	Kansas City	$0.29
Baltimore	.22½	Los Angeles	.25
Birmingham	.26	Minneapolis	.22
Boston	.25	Montreal	.24½
Chicago	.20	New Orleans	.23½
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.24
Dallas	.18	San Francisco	.20½
Denver	.23	Seattle	.20½
Detroit	.24½	St. Louis	.19½

ROOFING MATERIALS—Dealers' quotations, f.o.b., New York, to contractors in carloads:

Asphalt felt, per 100 lb	$3.50
Tar felt, per 100 lb	3.27½
Asphalt coating, per gal	.40
Tar pitch, in 350 lb. barrels, per ton	31.00

PREPARED ROOFINGS—Dealers' quotations to contractors, in carloads, f.o.b. New York.

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:
AA .....83% A .....86% B.....88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.1967	.2173
Birmingham	.22	.245	Montreal	.195	.22
Boston	.23	.25	New Orleans	.235	.26
Chicago	.195*	.22*	New York	.26‡	.2825‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.24	.29	St. Louis	.215	.235
Denver, f.o.b.	.1925	.215	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.16	.185

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Dealers' quotations on rough Douglas fir, No. 1 common, at yards; for delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft. No. 1 Douglas Fir	22 and 24 Ft. No. 1 Douglas Fir
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Dealers' quotations, f.o.b., in carloads, per M. ft. b.m.; for delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$40.00	$42.00
3x10 to 10x10	48.50	42.00
3x12 to 12x12	58.50	42.00
3x14 to 14x14	70.50	43.00

New York—Quotations per M. ft., b.m., wholesale, for rough, long-leaf, yellow-pine timbers in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under Long-Leaf Yellow Pine	22-24 Ft. Long-Leaf Yellow Pine
3x4 to 8x8	$43.00@$45.00	$44.00@$46.00
3x10 to 10x10	50.00@ 52.00	51.00@ 55.00
3x12 to 12x12	57.00@ 59.00	58.00@ 60.00
3x14 to 14x14	65.00@ 67.00	66.00@ 68.00

Other Cities—Dealers' quotations, delivered, per M.ft., b.m.:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$45.00	.....	.....	.....	$65.00	.....
Baltimore	36.00	$50.25	$54.00	$61.00	75.00	$50.25
Birmingham	45.00	.....	.....	.....	60.00	.....
Boston	48.00	47.00	47.25	47.50	57.00	51.00
Cincinnati	38.00	49.00	47.00	47.00	42.00	53.00
Cleveland	65.00	65.00	.....	.....	65.00	65.00
Dallas	65.00	56.00	.....	.....	65.00	54.00
Denver	.....	59.00	.....	.....	57.00	55.00
Detroit	65.00	55.00	.....	.....	67.50	55.00
Kansas City, Mo.	42.80	39.75	.....	.....	57.50	39.75
Los Angeles	.....	44.00	.....	.....	.....	44.00
Minneapolis	54.00	49.25	36.25‡	.....	54@56	49.25@50.75
Montreal	50.00	55.00	.....	.....	49.00	48.00
New Orleans	50.00	47.00	.....	44.00	67.00	64.00
Philadelphia	52.00	35.00	42.00	40.00	55.00	35.00
St. Louis	46.00	39.00	.....	.....	55.00	40.50
Seattle	.....	22.50	.....	.....	.....	22.50

	1x10 In. x 16 Ft. and Under, Rough			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$47.50	.....
Baltimore	56.00	$45.00	$45.00	35.00	$48.00
Birmingham	36.00	.....	.....	43.00	.....
Boston	44.00	42.75	42.00	48.00	47.50
Cincinnati	35.00	40.00	33.00	35.00	48.00
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	50.00	.....	.....	51.00
Detroit	42.00	42.00	.....	45.00	50.00
Kansas City, Mo.	50.50	45.75	.....	44.75	36.75
Los Angeles	.....	38.00	.....	.....	57.00
Minneapolis	49.00	43.00	38.75‡	49.00	44.00
Montreal	45.00	48.00	40.00	85.00	70.00
New Orleans	48.00	45.00	.....	50.00	50.00
Philadelphia	55.00	36.50	36.00	52.00	36.50
St. Louis	42.50	39.00	38.00	38.00	35.00
Seattle	.....	20.00	.....	.....	22.00

*Long-leaf yellow pine. †Douglas fir. ‡On cars

PILES—Dealers' quotations per lineal foot, pine, with bark on, f.o.b., New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41